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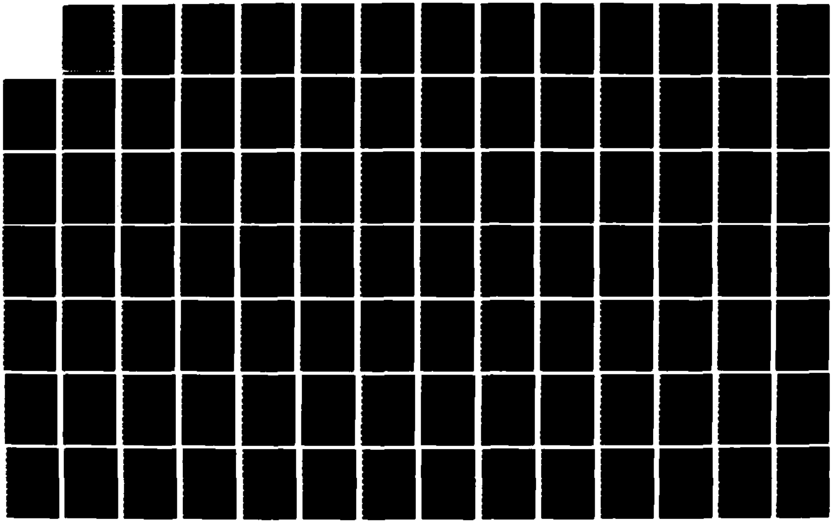

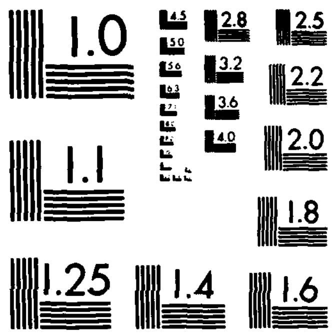

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DOT/FAA/PM-86/47

Program Engineering
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Washington, D.C. 20591

FAA Helicopter/Heliport Research, Engineering, and Development Bibliography, 1964-1986

Robert D. Smith
Federal Aviation Administration
Program Engineering and
Maintenance Service
Washington, D.C. 20591

November 1986

Bibliography

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16. Abstract

This report is a bibliography of FAA helicopter and heliport related documents published in the 1964-1986 time period. The list is limited to documents in which the research, engineering, and development elements of the FAA were involved as sponsors, participants, or authors.

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This bibliography was

1. INTRODUCTION. This report has been assembled as an aid for those who are interested in helicopter/heliport research, engineering, and development. This includes those within the Federal Aviation Administration (FAA), those in industry, and those in state and local governments.

2. SCOPE. In selecting documents to be included in this report, two limitations were ~~have been~~ observed. First, the documents are specifically related, in whole or in part, to helicopter operations. Second, they are limited to documents in which the research, engineering, and development elements (i.e., the ADL Complex) of the FAA have been involved as sponsors, participants, or authors. Citations include abstracts. Author and subject indexes are provided.

3. AVAILABILITY OF DOCUMENTS. The documents listed in the report are readily available from three sources:

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Vol-II	Graphical Prediction Methods
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FAA/CT-TN85/23	Test Plan for Siting, Installation, and Operational Suitability of the AWOS at Heliports (Rene A. Matos)
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FAA/PM-86/10	Very Short Range Statistical Forecasting of Automated Weather Observations (Robert G. Miller)
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FAA/PM-86/28	FAA/PM-86/45	

ICING (See also Weather)

FAA-RD-78-101	FAA-RD-80-24	FAA-CT-80-210
FAA/CT-81/35	FAA/CT-83/7	FAA/CT-83/21
FAA/CT-83/22	FAA/PM-84/22	FAA/CT-85/26

INERTIAL NAVIGATION SYSTEM

FAA-RD-76-146	FAA-RD-80-85	FAA/RD-82/7
FAA/RD-82/24		

INSTRUMENT LANDING SYSTEM (ILS)

FAA/RD-82/6	FAA/CT-TN85/24	FAA/PM-86/14
FAA/PM-86/15	FAA/PM-86/25,I	

LIGHTING (See Heliport Lighting)

LORAN-C (See also LOFF)

FAA-RD-70-10	FAA-RD-76-146	NA-78-55-LR
FAA-RD-78-101	FAA-RD-78-150	FAA-RD-80-20
FAA-RD-80-47	FAA-RD-80-85	FAA-RD-80-87
FAA-RD-80-88	FAA-CT-80-175	FAA-RD-81-27
FAA-RD-81-59	FAA/RD-82/6	FAA/RD-82/7
FAA/RD-82/16	FAA/RD-82/24	FAA/RD-82/57
FAA/RD-82/78	FAA/PM-83/4	FAA/PM-83/32
FAA/CT-TN85/5	FAA/CT-TN85/17	FAA/PM-86/14
FAA/PM-86/15		

LORAN-C VERTICAL NAVIGATION (VNAV)

FAA/RD-82/16

LORAN FLIGHT FOLLOWING (LOFF)

FAA-RD-80-85	FAA-RD-80-87	FAA-RD-80-88
FAA-RD-81-55	FAA-RD-81-59	FAA/CT-TN86/17

LOW-ALTITUDE COMMUNICATIONS (See also Northeast Corridor)

FAA-RD-78-101	FAA-RD-78-150	FAA-RD-79-123
FAA-RD-80-20	FAA-RD-80-80	FAA-RD-80-87
FAA-RD-81-9	FAA/RD-81/40	FAA-RD-81-59
PM-85-2 LR	FAA/PM-85/8	

LOW-ALTITUDE NAVIGATION (See also LORAN-C, Northeast Corridor, and GPS)

FAA-RD-71-96	FAA-RD-76-146	NA-78-55 LR
FAA-RD-78-101	FAA-RD-78-150	FAA-CT-80-18
FAA-RD-80-20	FAA-RD-80-80	FAA-RD-80-87
FAA-RD-81-59	FAA/PM-83/32	

LOW-ALTITUDE SURVEILLANCE (See also LOFF)

FAA-RD-78-150	FAA-RD-80-20	FAA-RD-80-80
FAA-RD-80-87	FAA-RD-81-59	

LOW SPEED APPROACHES

NA-68-21	FAA-RD-80-58	NAE-AN-26 (1985)
FAA/PM-86/14	FAA/PM-86/15	FAA/CT-TN86/31
NAE-AN-26 (1985)		

MLS FLIGHT INSPECTION (See Flight Inspection)

MICROWAVE LANDING SYSTEM (MLS), GENERAL (See also DME)

FAA-RD-78-101	FAA/RD-82/6	FAA/RD-82/40
FAA/CT-TN84/16	FAA/CT-TN84/20	FAA/CT-TN84/40
FAA/PM-85/7	FAA/CT-TN85/15	FAA/CT-TN85/53
FAA/CT-TN85/55	FAA/CT-TN85/58	FAA/CT-TN85/63
FAA/CT-TN85/64	FAA/CT-86/14	FAA/PM-86/14
FAA/PM-86/15	FAA/AVN-200/25 (1986)	

MLS RNAV

FAA-RD-80-59	FAA/RD-82/40	FAA/PM-85/7
FAA/CT-TN85/63	FAA/PM-86/25, I	

MLS SITING

FAA/CT-TN84/40	FAA/CT-TN85/53	FAA/CT-85/58
FAA/CT-TN85/64		

MLS TERPS (See also TERPS)

FAA-RD-80-59	FAA-RD-81-167	FAA/CT-TN84/16
FAA/CT-TN84/20	FAA/CT-TN85/53	FAA/CT-TN85/55
FAA/CT-TN86/31	FAA/AVN-200-25 (1986)	

MILITARY TRAINING ROUTES

FAA-RD-80-88, I

NAVIGATION SATELLITE TIMING AND RANGING (NAVSTAR) (See GPS)

NEAR MID-AIR COLLISIONS (See also TCAS)

FAA-RD-80-88, I	FAA/CT-83/40	FAA/PM-85/6

NOISE

FAA-RD-73-145	FAA-RD-75-79	FAA-RD-75-125
FAA-RD-75-190	FAA-RD-76-1	FAA-RD-76-49
FAA-RD-76-116	FAA-RD-77-57	FAA-RD-77-94
FAA-RD-78-101		

Note: During the late 1970's, responsibility for issues regarding helicopter noise was transfered to the FAA Office of Environment and Energy (AEE). The reports listed in this bibliography are limited to those in which the research, engineering, and development elements (i.e., the ADL complex) of the FAA have been involved as sponsors, participants, or authors. Since AEE is outside the ADL complex, the reports they have published on helicopter noise are not listed herein.

NONDIRECTIONAL BEACON

FAA-RD-76-146	FAA-RD-78-101	FAA-RD-78-150
FAA-RD-80-85	FAA/RD-82/6	FAA/PM-86/25,I

NONPRECISION APPROACHES (See also Airborne Radar Approaches)

NA-80-34-LR	FAA-CT-80-175	FAA-RD-81-27
FAA/RD-82/8	FAA/RD-82/9	FAA/RD-82/16
FAA/RD-82/71	FAA/RD-82/78	FAA/CT-82/103
FAA/CT-TN83/03	FAA/CT-TN84/34	FAA/CT-TN85/17
FAA/PM-86/25,I		

NORTHEAST CORRIDOR

FAA-RD-70-10	FAA-RD-80-17	NA-80-34-LR
FAA-RD-80-59	FAA-RD-80-80	FAA-CT-80-175
FAA-RD-81-59	FAA/CT-82/57	FAA/RD-82/78
FAA/CT-TN85/17		

OBSTRUCTION AVOIDANCE (See also Airborne Radar Approaches and TERPS)

FAA-RD 81-59	FAA-RD-80-107	FAA/PM-86/28

OFFSHORE OPERATIONS (See also Gulf of Mexico and Airborne Radar Approaches)

FAA-RD-76-123	FAA-RD-76-146	NA-78-55-LR
FAA-RD-79-123	FAA-RD-80-20	NA-80-34-LR
FAA-RD-80-87	FAA-RD-80-107	FAA-RD-81-27
FAA-RD-81-55	FAA/RD-82/6	FAA/PM-83/4

OMEGA

NA-78-55-LR	FAA-RD-78-101	FAA-RD-78-150
FAA-RD-80-85	FAA-RD-80-88,II	FAA/RD-82/6
FAA/PM-86/14	FAA/PM-86/15	

PRECISION APPROACH RADAR (PAR)

FAA-RD-80-107

RNAV (See Area Navigation)

ROTOR BLADE CONTAINMENT

FAA-RD-77-100

SAFETY (While this topic is addressed in most of the documents in this bibliography, the following documents are of particular interest.)

FAA/CT-83/6	PM-85-2-LR	PM-85-3-LR
PM-85-4-LR	FAA/PM-85/6	FAA/PM-86/28
FAA/PM-86/45		

SIMULATION

NA-68-21	FAA-RD-79-59	FAA-RD-80-64
FAA-RD-80-86	FAA-RD-80-86	FAA-RD-80-88
FAA-RD-81-59	FAA/CT-85/11	FAA/PM-86/14
FAA/PM-86/15		

TACAN

FAA-RD-76-146	FAA-RD-78-101	FAA-RD-80-88, II
FAA/RD-82/6	FAA/RD-82/63	

TERMINAL INSTRUMENT PROCEDURES (TERPS)

FAA-RD-78-150	FAA-RD-80-17	FAA-RD-80-58
FAA-RD-80-59	FAA-RD-80-80	FAA-RD-80-107
FAA-CT-81-167	FAA/CT-TN84/16	FAA/CT-TN84/20
FAA/CT-TN85/15	FAA/CT-TN85/24	FAA/CT-TN85/53
FAA/CT-TN85/55	FAA/PM-86/14	FAA/PM-86/15
FAA/AVN-200-25 (1986)		

TILT ROTOR

FAA-RD-78-150

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)

FAA/RD-82/63	FAA/CT-83/40	FAA/PM-85/6
FAA/PM-85/30	FAA/CT-TN85/49	FAA/CT-TN85/60
FAA/CT-TN85/83		

TRAINING

FAA-RD 78-150	FAA-RD-80-88	FAA-RD-81-59
FAA/CT-83/6	FAA/CT-TN85/55	FAA/PM-86/28
FAA/PM-86/45	FAA/AVN- 200/25 (1986)	

VERY LIGHT WEIGHT AIR TRAFFIC MANAGEMENT EQUIPMENT (VLATME)

FAA-RD-80-87

VOR

FAA-RD-71-96	FAA-RD-76-146	FAA-RD-78-101
FAA-RD-78-150	FAA-RD-80-17	NA-80-34-LR
FAA-RD-80-64	FAA-RD-80-85	FAA/RD-82/6
FAA/RD-82/78	FAA/CT-TN85/24	FAA/PM-86/14
FAA/PM-86/15	FAA/PM-86/25,I	

WAKE VORTEXES

RD-64-4	RD-64-55	FAA-RD-74-48
FAA-RD-78-143	FAA-RD-80-87	FAA-RD-80-88,II

WEATHER (See also Icing)

RD-64-4	FAA-RD-75-94	FAA-RD-78-101
FAA-RD-79-59	FAA-RD-79-64	FAA/RD-81/92
FAA/CT-83/6	FAA/PM-84/22	FAA/PM-84/25

WEATHER FORECASTS

FAA/RD-81/40	FAA-RD-81-92	FAA/PM-84/31
FAA/PM-86/10		

WEATHER OBSERVATIONS

FAA/RD-81/40	FAA/CT-TN85/23

WIND SHEAR

FAA-RD-79-59

WORKLOAD

FAA-RD-78-157	FAA-RD-79-64	FAA-RD-79-99
FAA-RD-80-58	FAA-RD-81-59	FAA/CT-TN85/15
FAA/CT-TN85/55	FAA/CT-TN85/58	NAE-AN-26 (1985)
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CLEMENT, WARREN F. (Systems Technology)

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APPENDIX D: ACRONYMS

ABC	Advancing blade concept
ADF	Automatic direction finder
AM	Amplitude modulated
AMA	Analytical Mechanics Associates
ARINC	Aeronautical Radio Inc.
ATC	Air traffic control
AWOS	Automated weather observing system
AWOS GEM	AWOS generalized equivalent markov
E-L	Electroluminescent
EMS	Emergency medical service
FAA	Federal Aviation Administration
FAATC	FAA Technical Center
FLIR	Forward looking infared radar
GEM	Generalized equivalent markov
GPS	Global positioning system
HAA	Helicopter Association of America
HAI	Helicopter Association International
HF	High frequency
IFR	Instrument flight rules
ILS	Instrument landing system
INS	Inertial navigation system
LOFF	Loran flight following
MLS	Microwave landing system

NAE	National Aeronautical Establishment
NAFEC	National Aviation Facilities Experimental Center
NASA	National Aeronautics and Space Administration
NAVSTAR	Navigation satellite timing and ranging
NRL	Naval Research Laboratory
PAR	Precision approach radar
RNAV	Area navigation
SCT	Systems Control Technology
STOL	Short takeoff and landing
TCAS	Traffic alert and collision avoidance system
TERPS	Terminal instrument procedures
VFR	Visual flight rules
VLATME	Very light weight air traffic management equipment
VNAV	Vertical navigation
VOR	Very high frequency omnidirectional radio range
VTOL	Vertical takeoff and landing

APPENDIX E: ABSTRACTS

Technical Report Documentation Page

1. Report No. RD-64-4	2. Government Accession No. AD-436746	3. Recipient's Catalog No.
4. Title and Subtitle State-of-the-Art Survey for Minimum Approach, Landing, and Takeoff Intervals as Dictated by Wakes, Vortices, and Weather Phenomena		5. Report Date January 1964
		6. Performing Organization Code
7. Author(s) W. J. Bennett		8. Performing Organization Report No.
9. Performing Organization Name and Address Boeing Airplane Division Renton, Washington		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. FA-WA-4450
12. Sponsoring Agency Name and Address Federal Aviation Administration Systems Research and Development Service Washington, D.C.		13. Type of Report and Period Covered Phase I Final Report
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report is a study of the generation and decay of the wake behind an aircraft, both in free air and ground effect, and its effect on following aircraft. An analysis is presented for both fixed- and rotarywing aircraft which defines the wake movement with time and the wake-induced velocities. The wake due to the propulsion system is analyzed both for normal operation and reversed thrust, as well as for pure propulsion lift. The influence of atmospheric parameters such as wind, temperature, and turbulence is discussed as it applies to the generation and decay of the wake.

17. Key Words VTOL STOL Wake Vortex Aircraft Separations Air Traffic Control	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
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Analytical Determination of the Velocity Fields in the Wakes of Specified Aircraft	May 1964
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7. Author(s) W.J. Bennett	8. Performing Organization Report No.
9. Performing Organization Name and Address Boeing Airplane Division Renton, Washington	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. FA-WA-4450
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	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report documents Phase II of a two-part study for the prediction of the velocity fields in the wakes of fixed-wing and rotary-wing aircraft. The material presented in this report, together with that in RD-64-4, comprises one part of a large program directed toward determining safe separation times and distances for aircraft operating in the air terminal traffic pattern.

Thirty-three aircraft currently operating within the Air Traffic Control system are analyzed. Numerical data are presented in tabular and curve form for eleven of the aircraft, defining their respective wake velocity fields.

A discussion of the assumptions and limitations of the analytical models used is included along with a discussion of possible correlation of the calculated values with test results.

17. Key Words	18. Distribution Statement
VTOL STOL Wake Vortex Aircraft Separations Air Traffic Control	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	[illegible]	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NA-67-1		

4. Title and Subtitle
An Analysis of the Helicopter Height Velocity Diagram including a Practical Method for its Determination

5. Report Date
February 1968

6. Performing Organization Code

7. Author(s)
William J. Hanley Gilbert DeVore

8. Performing Organization Report No.
NA-67-1 (DS-67-23)

9. Performing Organization Name and Address
Federal Aviation Administration
National Aviation Facilities Experimental Center
Atlantic City, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address
Federal Aviation Administration
Aircraft Development Service
Washington, D.C. 20591

14. Sponsoring Agency Code
Final Report

15. Supplementary Notes

16. Abstract

A composite summary analysis was made of the height-velocity (H-V) diagram test data obtained from the flight testing of three single engine, single rotor helicopters of varying design characteristics and basic parameters. The purpose of this analysis was to ascertain if a practical method for the determination of the H-V diagram could be evolved, as well as a means to determine the effects of aircraft weight and altitude on the H-V diagram. Analysis disclosed that H-V diagrams can be developed for any conventional single rotor helicopter by the flight test determination of a single maximum performance critical speed (Vcr) point in conjunction with the use of a non-dimensional curve and the solution of specific key point ratios which are set forth in the report. An evaluation of the H-V diagram key point relationships is presented followed by a discussion of the observed factors affecting autorotative landing following power failure. A suggested step by step procedure for flight manual type H-V diagrams is also presented.

17. Key Words	18. Distribution Statement
Helicopter Height Velocity Diagram Autorotation	Document is on file at the NAFEC Library, Atlantic City, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	36	

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Technical Report Documentation Page

1. Report No. [illegible]	2. Government Accession No. AD-670006	3. Recipient's Catalog No.
4. Title and Subtitle VTOL and STOL Simulation Study		5. Report Date April 1968
		6. Performing Organization Code
7. Author(s) Robert Conway		8. Performing Organization Report No. NA-67-21 (RD-67-65)
9. Performing Organization Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A simulation study was conducted to determine the effect on air traffic control when both Vertical and Short Takeoff and Landing (VTOL and STOL) aircraft are introduced into a terminal air traffic control environment.

It was concluded that VTOL and STOL aircraft could be accommodated in the terminal area using present operational procedures as contained in the Terminal Air Traffic Control Manual 7110.8. However, when VTOL and STOL aircraft reduced from terminal area speed to a slow final approach speed, difficulties were encountered in providing not only the desired spacing between these aircraft but between these aircraft and conventional aircraft in the sequence to and on the final approach course.

It was recommended that, in the planning of future VTOL and STOL aircraft ports, consideration be given to the location and runway alignment in order that the traffic flow of this airport be compatible with that of other traffic. It was also recommended that flight tests be conducted under simulated Instrument Flight Rule conditions to determine the most favorable relationship between glide slope angle, rate of descent and approach speed for both Vertical and Short Takeoff and Landing aircraft. It was further recommended that the feasibility of non-standard separation be examined in a live environment.

17. Key Words Air Traffic Control VTOL STOL Helicopter		18. Distribution Statement Document is on file at the NAFEC Library, Atlantic City, New Jersey 08405 DOCUMENT AVAILABLE FROM DTIC.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages [illegible]	22. Price

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Technical Report Documentation Page

1. Report No. NA-69-2	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Flight Test and Evaluation of Heliport Lighting for VFR		5. Report Date March 1969
		6. Performing Organization Code
7. Author(s) Richard Sulzer, Thomas Paprocki		8. Performing Organization Report No. NA-69-2 (RD-68-61)
9. Performing Organization Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The guidance value of heliport lighting system components was tested under VFR conditions in a joint FAA/U.S. Army effort. The overall system included lighting to identify and locate the heliport and support the approach and landing of helicopters.

Forty-six civil and military pilots flew on 11 nights at Tipton Army Airfield, Fort Meade, Maryland, producing the following conclusions: The heliport beacon, flashing green-yellow-white, had adequate range and distinctiveness but could be improved by a change in flash rate; the yellow pad perimeter lighting met all requirements; the white approach direction and yellow landing direction lighting components were satisfactory; both pad surface floodlighting and pad insert lights were used satisfactorily, and all pilots who were shown the painted maltese cross marking rated it as an aid at night; the lighted wind sock provided adequate wind direction information if overflown first, but neigher the lighted wind sock nor the lighted wind tee tested were adequate to provide this information to a pilot on the approach path at one-half mile from the pad.

A minimum VFR heliport lighting system is recommended to include the beacon for location information, the perimeter lights and painted marking for pad identification, and the lighted wind sock to provide wind information. Other components are recommended for installation when required by special conditions.

17. Key Words Heliport Lighting Heliport Beacon Heliport Marking		18. Distribution Statement Document is on file at the NAFEC Library, Atlantic City, New Jersey 08405	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 47	22. Price

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-70-10	AD-705507	

4. Title and Subtitle	5. Report Date
EVALUATION OF LORAN-C/D AIRBORNE SYSTEMS	April 1970
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
George H. Quinn	FAA-NA-70-7
9. Performing Organization Name and Address	10. Work Unit No.
FEDERAL AVIATION ADMINISTRATION National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405	11. Contract or Grant No. Project No. 330-014-03X
	13. Type of Report and Period Covered Final Report November 1966 - November 1969
12. Sponsoring Agency Name and Address DEPARTMENT OF TRANSPORTATION Federal Aviation Administration Systems Research & Development Service Washington, D. C. 20590	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The performance of three Loran-C airborne receiver/computer systems was investigated during flights in the U. S. Northeast Corridor to determine the feasibility of using Loran-C signals and equipment to navigate V/STOL vehicles in that area. Flight tests were conducted in a C-130 and DC-6 fixed wing aircraft, and a CH-47C Helicopter. Tracking radar was used on several of the flights to determine the airborne Loran-C equipment accuracy. Oscilloscope photographs of the received signals and strip chart recordings of the received 50 kHz to 150 kHz spectrum were used to establish the Loran-C signal, noise, and interference conditions throughout the Northeast Corridor. Test results showed that existing Loran-C signals and the systems did establish aircraft positions from the ground to operating altitudes in the Northeast Corridor. However, the equipment interfering signal rejection ability and reliability were not adequate for immediate operational use.

17. Key Words	18. Distribution Statement
Loran-C Computers, airborne Radio Frequency Interferences-Loran-C Antennas, Loran-C Receivers Loran-C airborne	This report is approved for unlimited distribution. DOCUMENT AVAILABLE FROM NTIS.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	81	

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FAA-RD-71-96	2. Government Accession No. AD-735399	3. Recipient's Catalog No.

4. Title and Subtitle

ANALYTICAL STUDY OF THE ADEQUACY OF VOR/DME AND DME/DME GUIDANCE SIGNALS FOR V/STOL AREA NAVIGATION IN THE LOS ANGELES AREA

5. Report Date: December 1971

6. Performing Organization Code

7. Author(s)

Bernhart V. Dinerman

8. Performing Organization Report No. FAA-NA-71-45

9. Performing Organization Name and Address

National Aviation Facilities
Experimental Center
Atlantic City, New Jersey 08405

10. Work Unit No.

11. Contract or Grant No. (330-014-04X)
Project No. 045-390-01X

12. Sponsoring Agency Name and Address

FEDERAL AVIATION ADMINISTRATION
Systems Research and Development Service
Washington, D. C. 20591

13. Type of Report and Period Covered

Interim Report
July 1970 - June 1971

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

An analysis was performed by personnel of the National Aviation Facilities Experimental Center (NAFEC) to determine the adequacy of very high frequency omnirange/distance measuring equipment (VOR/DME) guidance signals for vertical/short takeoff and landing (V/STOL) aircraft area navigation (RNAV) in the Los Angeles (LAX) area. Guidance signals were derived from existing VOR/DME and "converted" VOR facilities. It was concluded that: (1) VOR/DME RNAV over seven approved routes was feasible when using the existing VOR/DME facilities; (2) DME/DME RNAV over the approved routes is feasible when using station-pair combinations from existing VOR/DME facilities and certain converted VOR stations; (3) Except for the last segment of the LAX to Van Nuys (VNY) direct route, VOR/DME RNAV over the hypothetical direct routes was feasible when using existing VOR/DME facilities; (4) Except for the last segment of the LAX to VNY direct route, DME/DME RNAV over the direct routes was feasible when using station-pair combinations from existing VOR/DME facilities and certain converted VOR stations; (5) RNAV using DME/DME was potentially more accurate than VOR/DME; and (6) The number of en route station changeovers for VOR/DME and DME/DME RNAV over the approved and direct routes was considered acceptable.

17. Key Words

ea Navigation
l-Weather Aviation
Air Routes
/STOL Aircraft

18. Distribution Statement

Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	152	

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FAA-RD-71-105	2. Government Accession No. AD-745514	3. Recipient's Catalog No.
4. Title and Subtitle HELIPORT BEACON DESIGN, CONSTRUCTION, AND TESTING		5. Report Date December 1971 6. Performing Organization Code
7. Author(s) Fred Walter		8. Performing Organization Report No.
9. Performing Organization Name and Address SCIENTIFICO Scientific Components Company Newport Beach, California 92660		10. Work Unit No. 074-390-013 11. Contract or Grant No. FA70WA-2340
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D. C. 20591		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A heliport beacon production prototype was designed, constructed, and tested for optical performance and resistance to environmental conditions. The revolving beam beacon employs two 250 W, 130 V tungsten-halogen lamps, one each for the aviation green and aviation yellow projectors, and one 500 W, 120 V tungsten-halogen lamp for the white split beam projector. Lamp life is in excess of 5,000 hours at 115 V except with the 500 W lamp of the white beam projector, for which no 5,000 lamp has yet been found. The life of this lamp is approximately 3500 hours. The entire beacon system is sealed against the environment. The complete device weighs less than 50 pounds and can be mounted on standard light poles. It is about 16" in diameter and 24" tall. Low weight and cost are accompanied by low power consumption and minimal maintenance requirements, reducing the costs for installation and operation to a fraction of the amounts heretofore associated with devices of this kind.

17. Key Words Beacons Heliport Helicopter Heliport Beacons Rotating Beacons	18. Distribution Statement Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	62	

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-72-133	AD-753058	

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code
FLIGHT TEST AND EVALUATION OF HELIPORT LIGHTING FOR IFR	5. December 1972 / 6.
7. Author(s): Thomas H. Paprocki	8. Performing Organization Report No.: FAA-NA-72-89
9. Performing Organization Name and Address: National Aviation Facilities Experimental Center, Atlantic City, New Jersey 08405	10. Work Unit No.: / 11. Contract or Grant No.: Project 074-390-02X
12. Sponsoring Agency Name and Address: FEDERAL AVIATION ADMINISTRATION, Systems Research and Development Service, Washington, D. C. 20591	13. Type of Report and Period Covered: Final, March 1969 - October 1972 / 14. Sponsoring Agency Code:

15. Supplementary Notes

16. Abstract

Various approach lighting system patterns, developed through mockup and VFR flight testing efforts, were evaluated to determine their effectiveness in providing visual guidance for helicopter IFR approach and landing operations. Four basic lighting configurations were flown, under actual IFR weather conditions, by experienced helicopter subjects pilots. As a result of information collected through in-flight recording of objective data and post flight completion of pilot questionnaires, one of the lighting patterns was chosen as most effective for the conditions specified.

17. Key Words	18. Distribution Statement
Heliport Lighting Helicopter Guidance Visual Aids	Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	26	

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Technical Report Documentation Page

1. Report No. FAA-RD-73-47	2. Government Accession No. AD-759864	3. Recipient's Catalog No.

4. Title and Subtitle
ATC CONCEPTS FOR V/STOL VEHICLES
PARTS 1 AND 2

5. Report Date: April 1973

6. Performing Organization Code

7. Author(s) Sidney B. Rossiter, John Maurer, and Paul J. O'Brien

8. Performing Organization Report No. FAA-NA-72-95

9. Performing Organization Name and Address
Federal Aviation Administration
National Aviation Facilities Experimental Center
Atlantic City, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No. 015-190

13. Type of Report and Period Covered
Final
March 1971 - August 1972

12. Sponsoring Agency Name and Address
Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20591

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract Two dynamic simulations were conducted, using saturated Short Takeoff and Landing (STOL) aircraft traffic sample inputs, to study the effects of various aspects of STOL aircraft operations within the Air Traffic Control System. One investigated the effects of STOL aircraft operating at a downtown STOLport within the New York terminal area complex; the other investigated the effect of STOL aircraft operating on various configurations of STOL runways at a high-density, multi-runway, conventional takeoff and landing (CTOL) airport. It was concluded that STOL operations can be accommodated at a downtown STOLport; however, where airspace is limited, intricate profiles requiring a high degree of aircraft performance may be required. The performance of these profiles should be an onboard responsibility using highly accurate area navigation equipments with the ATC facility serving as a monitor. The current method of controller speed commands can be used as an interim method of metering and spacing pending more sophisticated methods, but requires flexible aircraft speed parameters and close cooperation between pilot and controller. As an aid to airspace utilization, a glide slope of 7 1/2° is beneficial and may be essential. It was further concluded that the least effect on CTOL operations at a CTOL/STOL airport is achieved by a parallel system of STOL runways bordering upon the CTOL complex. The techniques for controlling STOL aircraft at a CTOL airport are similar to those applied to CTOL aircraft; however, more emphasis is placed on speed control as opposed to radar vectoring because of the criticalness of the operation within the confines of limited airspace. A steep glide slope, preplanned pilot-performed flight tracks, and the limiting of the number of STOL routes into the terminal area are aids to an efficient STOL operation.

17. Key Words	18. Distribution Statement
STOL Terminal ATC	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	63	

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-73-145	AD-774794	

4. Title and Subtitle
V/STOL NOISE PREDICTION AND REDUCTION

5. Report Date
August 1973

6. Performing Organization Code

7. Author(s)
W. A. Guinn, D. F. Blakney, J. S. Gibson

8. Performing Organization Report No.
LG73ER0062

9. Performing Organization Name and Address
LOCKHEED-GEORGIA COMPANY
Marietta, Georgia

10. Work Unit No.
TRAIS - 36318

11. Contract or Grant No.
DOT-FA72WA-3099

12. Sponsoring Agency Name and Address
DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Systems Research & Development Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Final Report
June 1972 - August 1973

14. Sponsoring Agency Code

15. Supplementary Notes
Prediction techniques apply primarily to V/STOL aircraft with jet stream augmented lift systems.

16. Abstract
A four Phase program is described. Phase I was concerned with the identification of noise sources in rotary and jet stream type propulsion systems for V/STOL aircraft. In order to facilitate the noise source identifications and provide needed data for subsequent work, an extensive bibliography (809 references) was compiled. Phase II work covers the definition of noise generating mechanisms for jet stream V/STOL systems. Phase III discusses the noise reduction concepts which are applicable. In Phase IV, hand calculation and computer programs are derived and presented for predicting the far field noise environment of various types of V/STOL aircraft.

17. Key Words
Acoustics, Noise Prediction, Aircraft Noise, Noise Reduction, V/STOL Noise, Aerodynamic Noise

18. Distribution Statement
Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	396	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-74-48	AD-780053	

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code / 8. Performing Organization Report No.
A SUMMARY OF HELICOPTER VORTICITY AND WAKE TURBULENCE PUBLICATIONS WITH AN ANNOTATED BIBLIOGRAPHY	5. May 1974
	6.
7. Author(s): Jack J. Shrager	8. FAA-NA-73-68
9. Performing Organization Name and Address: Federal Aviation Administration, National Aviation Facilities Experimental Center, Atlantic City, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: 214-531-090
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D. C. 20590	13. Type of Report and Period Covered: Final, January 1965 - November 1973
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A review of all literature published since 1964 relating to helicopter vortex systems and wake turbulence was made. The results of this review are evaluated and summarized, and conclusions are drawn relative to that review. The documents are grouped in general categories, and this is further supplemented by an annotated bibliography and authors index. Also incorporated in the review is a comparative analysis of rotary-wing versus fixed-wing circulation intensity time-history.

17. Key Words	18. Distribution Statement
Helicopter Wakes, Rotor Aerodynamics, Airflow, Flow Distortion, Vortices, Vortex Models, Rotor Noise, Rotor, Helicopter Terminal Area Operations	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	187	

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Technical Report Documentation Page

1. Report No. FAA-RD-75-79	2. Government Accession No. AD-A014640	3. Recipient's Catalog No.
4. Title and Subtitle A Comprehensive Review of Helicopter Noise Literature		5. Report Date June 1975
		6. Performing Organization Code
7. Author(s) B. Magliozzi, F.B. Metzger, W. Bausch, R.J. King		8. Performing Organization Report No.
9. Performing Organization Name and Address Hamilton Standard, Division of United Technologies Corp. Windsor Locks, Connecticut 06096		10. Work Unit No. (TRAIS) 36317
		11. Contract or Grant No. DOT-FA74WA-3477
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered SURVEY
		14. Sponsoring Agency Code ARD-650(2015-807)
15. Supplementary Notes		

16. Abstract

This report summarizes the state-of-the-art in helicopter noise. It includes a bibliography of reports on all components of helicopter noise including main rotor, tail rotor, engine and gearbox. Literature on helicopter noise reduction and subjective evaluation of helicopter noise were also included. Capsule summaries of important reports are included which describe the purpose of the report, summarizes the important results, compares the report with others on the same subject, and provides a critical evaluation of the work presented. It is concluded that the available prediction methodology provides a means for estimating helicopter sources on a gross basis. However, the mechanisms of noise generation are still not fully understood, although the experimental and theoretical tools are now available to conduct the definitive experiments and establish the mathematical models needed for accurate definition of helicopter noise generation mechanisms. Spectrum analyses of helicopter noise show that main rotor, tail rotor, and engine sources contribute significantly to annoyance. In cases where these sources have been heavily suppressed, gearbox noise will also appear as a significant contributor to annoyance. Therefore, quieter helicopters must include suppression of all of these components. For certification, the literature indicates that a new noise unit is required. This unit may use the effective perceived noise level concepts but should include corrections for impulsive noise, correctly address the influence of tones throughout the frequency spectrum, extend the spectrum of interest to very low frequencies, and correctly address the annoyance of noise components below 500 Hz. For assessing the community acceptance of helicopter noise, modification of the Day-Night Noise Level, L_{DN}, shows promise.

17. Key Words Helicopter Noise, Subjective Response, Impulsive Noise, Gearbox Noise, Bibliography, Rotor Noise, Gas Turbine Engine Noise, Annoyance Criterias, Noise Certification Criteria	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield Virginia 22151.

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 193	22. Price

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Technical Report Documentation Page

1. Report No FAA-RD-75-94	2. Government Accession No. AD-A019216	3. Recipient's Catalog No.
4. Title and Subtitle Wind and Turbulence Information for Vertical and Short Take-Off and Landing (V/STOL) Operations in Built-Up Urban Areas - Results of Meteorological Survey		5. Report Date June 1975
		6. Performing Organization Code
		8. Performing Organization Report No
7. Author(s) J. V. Ramsdell		
9. Performing Organization Name and Address Battelle, Pacific Northwest Laboratories Battelle Boulevard Richland, Washington 99352		10. Work Unit No (TRAIS)
		11. Contract or Grant No. DOT-FA72-WAI-263
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration System Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Winds and turbulence have been measured at typical urban STOL and VTOL port sites and at a conventional rural airport during a 9-month period. These measurements have been used to develop a set of turbulence models for use in: design of V/STOL aircraft stability and control features, development of airworthiness criteria for certification of V/STOL aircraft, and simulation of the turbulence in the urban terminal environment of V/STOL aircraft. The model set includes spectral models, rms gust velocity models and turbulence length scale models. Probability distributions are given for gust velocities and length scales. The data obtained during the study and the models derived therefrom are compared with conventional, flat-terrain turbulence models and data.

In addition, the report contains a review of atmospheric boundary layer theory and descriptions of the measurement sites, instrumentation and data processing. There is a discussion of spatial aspects of turbulence and an evaluation of the standard airport cup anemometer.

The appendices contain extensive summaries of the data collected. These summaries include: wind roses, wind and turbulence statistics for selected periods, turbulence spectra, gust velocity distributions, and length scale distributions.

17. Key Words V/STOL aircraft terminal operations, urban winds, turbulence models, gust velocities, turbulence length scales, turbulence data, instrumentation		18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages 421	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FA-RD-75-125	AD-A028765	
4. Title and Subtitle: V/STOL Aircraft Noise Prediction (Jet Propulsors)		5. Report Date: June 1975
		6. Performing Organization Code
7. Author(s): N. N. Reddy, D. F. Blakney, J. G. Tibbets, J. S. Gibson		8. Performing Organization Report No.: LG75ER0054
9. Performing Organization Name and Address: Lockheed-Georgia Company, Marietta, Georgia		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.: DOT-FA72WA-3099
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D. C. 20590		13. Type of Report and Period Covered: Final Report, June 1974 - June 1975
		14. Sponsoring Agency Code

15. Supplementary Notes

This report supersedes the earlier report No. FAA-RD-73-145; August 1973.

16. Abstract

A computer program is presented for predicting the noise levels of V/STOL aircraft with jet-propulsive-lift systems. Using the equations developed in Part I of this report the noise levels may also be estimated with hand calculations. Vectored thrust, externally blown flap, upper surface blown flap, internally blown flap, and augmentor wing are the propulsive-lift concepts considered. Semi-empirical equations are derived using the test results and theories for the following aircraft noise sources: internal engine, jet, excess (core engine), high-lift system, airframe, and auxiliary power unit. The computer program predicts the perceived noise levels and tone corrected perceived noise levels for V/STOL aircraft at any specified sideline distance for known geometrical and operational parameters. This report supersedes the earlier report No. FAA-RD-73-145, August 1973.

17. Key Words	18. Distribution Statement
Aircraft noise prediction, acoustics, V/STOL noise, noise control, aerodynamic noise.	Document is available to the public through the N.T.I.S., Springfield Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	309	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-75-190	AD-A018036	

4. Title and Subtitle	5. Report Date
NOISE CERTIFICATION CRITERIA AND IMPLEMENTATION CONSIDERATIONS FOR V/STOL AIRCRAFT	November 1975
	6. Performing Organization Code
7. Author(s): MAN-Acoustics and Noise, Inc.	8. Performing Organization Report No.: MAN-101H
9. Performing Organization Name and Address: MAN-Acoustics and Noise, Inc. 2105 N. E. 45th St. Seattle, WA 98103	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DOT-FA74WAI-490
12. Sponsoring Agency Name and Address: U. S. Dept. of Transportation Federal Aviation Administration Systems Research and Development Service Washington, DC 20590	13. Type of Report and Period Covered: Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Although this first phase of a two-phase program emphasized the extent that Perceived Noise Level in PNdB, Perceived Level in dBA, and corrections to these engineering calculation procedures reflected annoyance to next generation STOL aircraft noise signatures, other aspects of certification implementation were also considered and will be emphasized in a report on the second phase of the program.

As a means of determining the accuracy and reliability of engineering calculation procedures that could be utilized as a basis for noise certification of V/STOL commercial aircraft, 36 persons made annoyance judgments to 34 noise signals presented at 5 different levels. The signals included recordings of conventional jet aircraft operations, turboprop and reciprocating engine powered commercial aircraft, helicopter flybys, and simulations of V/STOL operations. Both relative annoyance and absolute acceptability judgments were obtained. Some of the results are:

- For flyover (not hover) operations EPNdB validly and reliably predicts annoyance.
- For hover type of operations EPNdB under predicts annoyance.
- When applied to all aircraft types, the FAR-36 tone correction degrades reliability for both PNdB and dBA while the duration correction improves reliability to a significant extent.
- A difference between calculated and judged values should be equal-to-or-greater-than 3 EPNdB in order to conclude that the difference is reliable.

17. Key Words	18. Distribution Statement
V/STOL Certification Aircraft Noise Annoyance to Noise	Document is available to the public through National Technical Information Service, Springfield, Virginia 22151.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	81	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-76-1	AD-A035671	

4. Title and Subtitle	5. Report Date
HUMAN RESPONSE TO SOUND: THE CALCULATION OF PERCEIVED LEVEL, PLdB (NOISINESS OR LOUDNESS) DIRECTLY FROM PHYSICAL MEASURES	NOVEMBER 17, 1976
	6. Performing Organization Code: 202-553-001
7. Author(s): THOMAS H. HIGGINS	8. Performing Organization Report No.
9. Performing Organization Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20590	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: In-House R&D, 202-553-001
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20590	13. Type of Report and Period Covered: Final Report
	14. Sponsoring Agency Code: 202-553-001

15. Supplementary Notes

16. Abstract The relationship between the perceived level, PLdB, of sound (loudness or noisiness) is shown to be a function of the sound pressure squared and the sound frequency squared, i.e. PLdB = k p^2 f^2. A logarithmic formula employing this basic relationship between perceived level and pressure and frequency has been developed and is found to be as accurate as the more complex methods currently in use, i.e. PLdB = 14 + 20 Log_{10} P (μB) + 20 Log_{10} f (Hz) which is equal to the following: PLdB = P(dB)-60 + 20 Log_{10} F (Hz). The perceived level of an aircraft takeoff or landing is demonstrated to be equal, to the logarithmic sum of the perceived levels calculated using the above formula, for each octave band or 1/3 octave band, i.e. PLdB = 10 Log_{10} [antilog_{10} $\text{PLdB}_1/10$ + antilog_{10} $\text{PLdB}_2/10$ ....+ antilog_{10} $\text{PLdB}_N/10$]

The results are found to be more accurate than the complex methods currently in use for the useful range of sound pressure levels and frequencies found to be associated with operational aircraft including helicopters, turbofan, turboprop and turbojet powered aircraft. This work, therefore, provides the systems engineer an easily understood and useful design and evaluation method. The formula developed clearly shows the design engineer and management personnel the relationship between the physical characteristics of an evolving system and its potential impact on human and community response.

17. Key Words	18. Distribution Statement
Sound Perceived Level Human Response Engineering Calculation Procedure Physical Measures	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	45	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-76-49, I	AD-A027389	

4. Title and Subtitle	5. Report Date
V/STOL ROTARY PROPULSION SYSTEMS - NOISE PREDICTION AND REDUCTION Volume I - Identification of Sources, Noise Generating Mechanisms, Noise Reduction Mechanisms, and Prediction Methodology	May 1976
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
B. Magliozzi	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Hamilton Standard Division of United Technologies Corp. Windsor Locks, Connecticut 06096	11. Contract or Grant No. DOT-FA74WA-3477
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington D.C. 20590	Final Report
	14. Sponsoring Agency Code ARD-650 (2015-607)

15. Supplementary Notes

16. Abstract

The propulsion systems of current and future V/STOL vehicles can be defined as combinations of free-air propellers, shrouded propellers, variable pitch fans, fixed pitch fans, tilt rotors, helicopter rotors, lift fans, gearboxes, and drive engines. In this report, noise sources for each of these propulsors, gearboxes, and drive engines are identified and rank ordered. The noise generating mechanisms for each of the propulsor noise sources identified are defined and systematically catalogued. Three approaches to reduction of propulsor noise are discussed: changes in physical geometry, changes in design operating conditions, and the use of acoustic treatments. Computerized and graphical procedures based on methodology from the open literature and at United Technologies Corp., are presented for predicting aerodynamic performance of and noise from the V/STOL propulsors identified in this study. The developed methodology allows the user to estimate the achieved noise reduction as well as the incurred performance penalties of noise reduction design features and noise attenuation devices such as partly sonic inlets and acoustic treatment. It is shown that much of the noise generating mechanism substantiation data and prediction methodology are based on static operation. Forward flight effects have recently been recognized as having a significant effect on the noise sources. Therefore, forward flight effect corrections are included in the methodology, but these have not been fully substantiated due to lack of data.

Related documents include Volume II - Graphical Prediction Methods and Volume III - Computer Program User's Manual.

17. Key Words		18. Distribution Statement
Variable Pitch Fan Noise Fixed Pitch Fan Noise Gas Turbine Engine Noise Helicopter Noise Lift Fan Noise	Propeller Noise Jet Noise Gearbox Noise Noise Prediction V/STOL Noise	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	137	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-76-49, II	AD-A027390	

4. Title and Subtitle	5. Report Date
V/STOL ROTARY PROPULSION SYSTEMS - NOISE PREDICTION AND REDUCTION Volume II - Graphical Prediction Methods	May 1976
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author's)	
B. Magliozzi	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Hamilton Standard Division of United Technologies Corp. Windsor Locks, Connecticut 06096	11. Contract or Grant No. DOT-FA74WA-3477
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington D.C. 20590	Final Report
	14. Sponsoring Agency Code ARD-650 (2015-607)

15. Supplementary Notes

16. Abstract

Graphical procedures for estimating noise and performance of free-air propellers, variable pitch fans with inlet guide vanes, variable pitch fans with outlet guide vanes, fixed pitch fans, helicopter rotors, tilt rotors, and lift fans are presented. Noise prediction methods for drive engines, gearboxes, jets with and without bypass flow, as well as noise reduction and performance losses for partly sonic inlets and duct linings are also presented. These graphical methods are parallel to those developed for the computer program discussed in Volume III of this report to the extent possible without their becoming too involved and tedious to use.

The procedures are extensive and applicable to a wide variety of V/STOL propulsor systems, including present and future V/STOL vehicles. The methods have been validated with available data wherever possible. However, high quality data for isolated propulsors which is free from contamination by other sources and ground reflections is somewhat limited, particularly for forward flight conditions.

Related documents include Volume I - Identification of Sources, Noise Generating Mechanisms, Noise Reduction Mechanisms, and Prediction Methodology and Volume III - Computer Program User's Manual.

17. Key Words		18. Distribution Statement
Variable Pitch Fan Noise	Propeller Noise	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151
Fixed Pitch Fan Noise	Jet Noise	
Gas Turbine Engine Noise	Gearbox Noise	
Helicopter Noise	Noise Prediction	
Lift Fan Noise	V/STOL Noise	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	295	

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Technical Report Documentation Page

1. Report No. FAA-RD-76-49, III	2. Government Accession No. AD-A025281	3. Recipient's Catalog No.
4. Title and Subtitle V/STOL ROTARY PROPULSION SYSTEMS - NOISE PREDICTION AND REDUCTION Volume III - Computer Program User's Manual		5. Report Date May 1976
		6. Performing Organization Code
7. Author(s) B. Magliozzi		8. Performing Organization Report No.
9. Performing Organization Name and Address Hamilton Standard Division of United Technologies Corp. Windsor Locks, Connecticut 06096		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA74WA-3477
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington D.C. 20590		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code ARD-650 (2015-607)
15. Supplementary Notes		

16. Abstract

A computer program is presented which allows a user to make performance and far-field acoustic noise predictions for free-air propellers, variable pitch fans with inlet guide vanes, variable pitch fans with outlet guide vanes, fixed pitch fans, helicopter rotors, tilt rotors, fixed pitch lift vanes with remote, integral, and tip-turbine drives, and variable pitch lift fans with remote and integral drives. Noise prediction methodology for drive engines, single stream and coaxial jets, and gearboxes are also included, as well as noise reduction and performance losses of partly sonic inlets and duct acoustic treatment.

A description of the program, detailed instructions for its use, required inputs, and sample cases are presented.

Related documents include Volume I - Identification of Sources, Noise Generating Mechanisms, Noise Reduction Mechanisms, and Prediction Methodology and Volume II - Graphical Prediction Methods.

17. Key Words Variable Pitch Fan Noise, Fixed Pitch Fan Noise, Gas Turbine Engine Noise, Helicopter Noise, Lift Fan Noise, Propeller Noise, Jet Noise, Gearbox Noise, Noise Prediction, V/STOL Noise	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	295	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-76-116	AD-A032028	

4. Title and Subtitle	5. Report Date
NOISE CERTIFICATION CONSIDERATIONS FOR HELICOPTERS BASED ON LABORATORY INVESTIGATIONS	July 1976
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No. MAN-1014
9. Performing Organization Name and Address MAN-Acoustics and Noise, Inc. 2105 North 45th St. Seattle, WA 98103	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FA74WAI-490
12. Sponsoring Agency Name and Address U. S. Dept. of Transportation Federal Aviation Administration Systems Research and Development Service Washington, DC 20590	13. Type of Report and Period Covered Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This is the second part of a program concerning noise certification for V/STOL and helicopter aircraft. Aspects considered were: an engineering calculation procedure which validly and reliably reflects annoyance to helicopter operations; estimates of noise exposure levels which could be compatible with human activities in areas surrounding heliports; noise exposure modeling for helicopter noise; certification measurement approaches for helicopter noise certification.

The basics of the program involved human response evaluations of conventional takeoff and landing (CTOL) aircraft noise, simulations of helicopter noise emphasizing "slap" or pulsating noise effects, and recordings of a wide variety of helicopter operations.

The main conclusion is that PNdB with the FAR-36 duration correction reliably reflects annoyance to helicopter noise. No correction for "slap" or tone is required. Also, dBA_D is almost as effective as $PNdB_D$ for measuring effects of helicopter noise (duration effects are included). Elimination of "heavy slap" is equivalent to a maximum of a 2 to 3 dBA reduction relative to annoyance response.

17. Key Words	18. Distribution Statement
Helicopter Certification Aircraft noise Annoyance to noise	Document is available to the public through National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	135	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-76-146	AD-A030337	

4. Title and Subtitle	5. Report Date
A COMPARISON OF AIR RADIONAVIGATION SYSTEMS (FOR HELICOPTERS IN OFF-SHORE AREAS)	August 1976
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
George H. Quinn	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Final
U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Washington D.C. 20591	14. Sponsoring Agency Code ARD-300

15. Supplementary Notes

16. Abstract

This paper examines the technical potential of ten navigation systems that may meet specific IFR en route navigation requirements for helicopters operating in off-shore areas. Technical factors considered essential for navigation are: (1) operational range, (2) operational altitude, (3) accuracy, and (4) reliability.

Not addressed in this paper are such operational factors as pilot workload, number of way points, type of display, etc.

Estimated user equipment cost will be included because of its importance in system selection.

17. Key Words	18. Distribution Statement
En route navigation requirement, operational range, altitude, accuracy, reliability	Document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	21	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-77-57, I	AD-A040561	

4. Title and Subtitle	5. Report Date
Helicopter Noise Measurements Data Report Volume I Helicopter Models: Hughes 300-C, Hughes 500-C, Bell 47-G, Bell 206-L	April 1977
	6. Performing Organization Code: ARD-550
7. Author(s): Harold C. True and Richard M. Letty	8. Performing Organization Report No.
9. Performing Organization Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
	13. Type of Report and Period Covered: Data Report
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	14. Sponsoring Agency Code: ARD-550

15. Supplementary Notes

16. Abstract

This data report contains the measured noise levels obtained from an FAA Helicopter Noise Test Program. The purpose of this test program was to provide a data base for a possible helicopter noise certification rule. The noise data presented in this two volume report is primarily intended as a means to disseminate the available information. Only the measured data is presented in this report. All FAA/DOT data analysis and comparisons will be presented in a later report which is scheduled for distribution in July,1977.

The eight helicopters tested during this Helicopter Noise Test Program constituted a wide range of gross weights and included participation from several helicopter manufacturers. The helicopter models used in this test program were the Hughes 300C, Hughes 500C, Bell 47-G, Bell 206-L, Bell 212 (UH-1N), Sikorsky S-61 (SH-3A), Sikorsky S-64 "Skycrane" (CH-54B), and Boeing Vertol "Chinook" CH-47C. Volume I contains the measured noise levels obtained from the first four helicopters while Volume II contains the data from the remaining four.

The test procedure for each helicopter consisted of obtaining noise data during hover, level flyover, and approach conditions. The data presented in this report consists of time histories, 1/3-octave band spectra, EPNL, PNL, dBA, dBD and OASPL noise levels.

17. Key Words	18. Distribution Statement
Helicopter Noise Levels; Hover; Level Flyover; Approach; Glide Slope; Time Histories; EPNL, PNL, dBA, dBD and OASPL.	This document is available to the public through the National Technical Information Service Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	386	

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Technical Report Documentation Page

1. Report No. FAA-RD-77-57, II	2. Government Accession No. AD-A040052	3. Recipient's Catalog No.
4. Title and Subtitle Helicopter Noise Measurements DATA REPORT -- Volume II Helicopter Models: Bell 212 (UH-1N), Sikorsky S-61 (SH-3A), Sikorsky S-64 "Skycrane" (CH-54B), Boeing Vertol "Chinook" (CH-47C)		5. Report Date April 1977
		6. Performing Organization Code ARD-550
7. Author(s) Harold C. True and Richard M. Letty		8. Performing Organization Report No.
9. Performing Organization Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591		13. Type of Report and Period Covered Data Report
		14. Sponsoring Agency Code

15. Supplementary Notes

Refer to the main text in Volume I which describes the test program and data presentation format.

16. Abstract

This data report contains the measured noise levels obtained from an FAA Helicopter Noise Test Program. The purpose of this test program was to provide a data base for a possible helicopter noise certification rule. The noise data presented in this two volume report is primarily intended as a means to disseminate the available information. Only the measured data is presented in this report. All FAA/DOT data analysis and comparisons will be presented in a later report which is scheduled for distribution in July,1977.

The eight helicopters tested during this Helicopter Noise Test Program constituted a wide range of gross weights and included participation from several helicopter manufacturers. The helicopter models used in this test program were the Hughes 300C, Hughes 500C, Bell 47-G, Bell 206-L, Bell 212 (UH-1N), Sikorsky S-61 (SH-3A), Sikorsky S-64 "Skycrane" (CH-54B), and Boeing Vertol "Chinook" CH-47C. Volume I contains the measured noise levels obtained from the first four helicopters while Volume II contains the data from the remaining four.

The test procedure for each helicopter consisted of obtaining noise data during hover, level flyover, and approach conditions. The data presented in this report consists of time histories, 1/3-octave band spectra, EPNL, PNL, dBA, dBD and OASPL noise levels.

17. Key Words Helicopter Noise Levels; Hover; Level Flyover; Approach; Glide Slope; Time Histories; EPNL, PNL, dBA, dBD and OASPL.	18. Distribution Statement This document is available to the public through the National Technical Information Service Springfield, Virginia 22151

19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages 417	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-77- 94	AD-A043842	

4. Title and Subtitle	5. Report Date
NOISE CHARACTERISTICS OF EIGHT HELICOPTERS	JULY 1977
	6. Performing Organization Code: ARD-550
7. Author(s): H. C. TRUE, E. J. RICKLEY*	8. Performing Organization Report No.
9. Performing Organization Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	13. Type of Report and Period Covered: FINAL REPORT
	14. Sponsoring Agency Code

15. Supplementary Notes *

Acoustic data acquired and processed into format by "Noise Measurement and Assessment Laboratory" Transportation Systems Center, Cambridge, Massachusetts

16. Abstract This report describes the noise characteristics of Eight Helicopters during level flyovers, simulated approaches, and hover. The data was obtained during an FAA/DOT Helicopter Noise Program to acquire a data base for possible helicopter noise regulatory action. The helicopter models tested were the Bell 47G, 206L, and 212 (UHIN), the Hughes 300C and 500C, the Sikorsky S-61 (SH-3B) and S-64 (CH-54B) and the Vertol CH-47C. The acoustic data is presented as Effective Perceived Noise Level, A-weighted sound pressure level and 1/3 octave band sound pressure level with a slow meter characteristic per FAR Part 36. Selected waveforms and narrow band spectra are also shown. Proposed methods to quantify impulsive noise ("blade slap") are evaluated for a level flyover for each of the Helicopters.

The tested helicopters can be grouped into classes depending upon where the maximum noise occurs during a level flyover. Helicopters with the higher main rotor tip speeds propagate highly impulsive noise ahead of the helicopter. The maximum noise for most of the helicopters occurs near the overhead position and appears to originate from the tail rotor. Unmuffled reciprocating engine helicopters appear to have significant engine noise behind the helicopter. Noise levels, when compared as a function of gross weight and flown at airspeeds to minimize "compressibility slap" form a band 7 EPNdB wide with a slope directly proportional to gross weight. The quieter helicopters have multibladed rotors and tipspeeds below 700 fps. The duration correction in EPNL is important in evaluating helicopter noise because it penalizes the longer time histories of the helicopters with significant blade slap during a level flyover.

17. Key Words	18. Distribution Statement
Helicopter Noise Levels; Effective Perceived Noise Level, Flyover Noise Time History, Main Rotor, Tail Rotor, Impulsive Noise.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	171	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-77-100	AD-A045314	

4. Title and Subtitle	5. Report Date
Study to Improve Turbine Engine Rotor Blade Containment	August 1977
	6. Performing Organization Code
7. Author's) K. F. Heermann R. H. Eriksson K. R. McClure	8. Performing Organization Report No. PWA 5551
9. Performing Organization Name and Address UNITED TECHNOLOGIES CORPORATION Pratt & Whitney Aircraft Group Commercial Products Division East Hartford, Conn., 06108	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DOT-FATQWA-3857
12. Sponsoring Agency Name and Address Federal Aviation Administration Systems Research and Development Service Washington, D. C. 20590	13. Type of Report and Period Covered Final Report August 1976 to August 1977 14. Sponsoring Agency Code ARD-520

15. Supplementary Notes

16. Abstract

An engineering study on a large turbofan engine was conducted to: (1) accurately estimate the engine weight increase and design criteria necessary to contain equivalent disk fragments resulting from a rotor failure, (2) evaluate forward containment for tip fragments of fan blades, (3) identify critical structural components and loads for the loss of an equivalent fan disk fragment through analysis of the rotor/frame transient dynamic response. The fragments studied for engine containment were disk fragments with energy equivalent to two adjacent blades and an included disk serration, and four adjacent blades and three included disk serrations. The forward containment study was made to determine the additional weight required to contain or deflect turbofan engine fan blade tip fragments up to 30 degrees forward of the plane of rotation, as measured from the axis of rotation.

The results of this study indicated significant weight increases for the engine in order to contain the equivalent disk fragments of two blades with an included disk serration and four blades with three included disk serrations. The total resultant engine weight increase (shown in Table 9) for the two blade fragment is 367 pounds and for the four blade fragment is 682 pounds.

17. Key Words	18. Distribution Statement
Turbofan engine, containment, disk fragment, blade fragment, transient dynamic response	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	57	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NA-78-55-LR		

4. Title and Subtitle	5. Report Date
Limited Test of LORAN-C and OMEGA for Helicopter Operations in the Offshore New Jersey Area	1978
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Robert H. Pursel	NA-78-55-LR
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City Airport, New Jersey 08405	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Federal Aviation Administration System Research and Development Service Washington, D.C. 20590	Letter Report
	14. Sponsoring Agency Code
	ARD-300

15. Supplementary Notes

16. Abstract

Limited flight tests were conducted using Loran-C and Omega guidance in the offshore Atlantic City area as part of the Helicopter IFR Operations Program at NAFEC. Tests were conducted using a prototype Loran-C system and a production Omega system both installed in a CV-580 aircraft. Approved offshore routes were flown and data was collected on both navigation systems. Precision radar tracking was used to determine aircraft position. Measured results on Omega navigation indicates mean ± 2 sigma crosstrack errors wihich in some cases are larger than a ± 2nm route width. Measured results on Loran-C navigation indicate mean ± 2 sigma crosstrack errors which are close to but do not exceed a ± 2 nm route width. The Loran-C figure, however, includes a bias error of about 1.2nm which was caused by a problem in the prototype receiver. According to the manufacturer, the problem has been corrected. If the bias is subtracted out, the mean ± 2 sigma Loran-C crossstrack error is well within a ± 2nm route width.

17. Key Words	18. Distribution Statement
Helicopter LORAN-C Offshore OMEGA Low Altitude Navigation Crosstrack Errors Flight Technical Error	Document is on file at the NAFEC Library, Atlantic City, Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	33	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-78-101	AD-A061921	

4. Title and Subtitle	5. Report Date
Helicopter Operations Development Plan	September, 1978
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Helicopter Program Staff ARD-706	PAR-517-78
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Federal Aviation Administration Systems Research and Development Service Helicopter Program Staff Trans Point, Washington, D. C. 20590	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Department of Transportation Federal Aviation Administration	Program Plan
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Helicopter Operations Development Plan is designed to provide for upgrading and development of all those criteria, standards, procedures, systems, and regulatory activities which will allow safe, timely and economical integration of the helicopter into all-weather operations in the National Airspace System. It describes a five-year development program whose objective is to improve the National Airspace System so as to enable helicopters to employ their unique capabilities. It includes the collection of data (both near and long term) for use by the FAA and others to ensure full integration into the NAS of this rapidly growing segment of aviation. These areas are covered in the plan: (1) IFR Helicopter Operations; (2) Navigation Systems Development; (3) Communication Systems Development; (4) Helicopter Air-Traffic Control; (5) Weather Environment; (6) All-Weather Heliport Development; (7) IFR Helicopter Certification Standards; (8) Helicopter Icing Standards; (9) Helicopter Crashworthiness and (10) Helicopter Noise Characterization. The FAA groups, other Federal Government agencies and other organizations participating in this effort are identified. Program management responsibilities are addressed. A program schedule with milestones is presented and program funding requirements are identified.

17. Key Words	18. Distribution Statement
Helicopter, All-Weather Operations, ATC Integration, All-Weather Certification, Icing Standards, Crashworthiness, Noise, Heliport, Communications, Navigation	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		118	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-78-143	AD-A068925	

4. Title and Subtitle	
AIRCRAFT WAKE VORTEX TAKEOFF TESTS AT TORONTO INTERNATIONAL AIRPORT	5. Report Date: February 1979
	6. Performing Organization Code: DTS-521
7. Author(s): T. Sullivan, J. Hallock, B. Winston, I. McWilliams, D. Burnham	8. Performing Organization Report No.: DOT-TSC-FAA-79-9
9. Performing Organization Name and Address: U.S. Department of Transportation, Research and Special Programs Administration, Transportation Systems Center, Cambridge MA 02142	10. Work Unit No. (TRAIS): FA905/R9111
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington DC 20591	13. Type of Report and Period Covered: Final Report June 1976-June 1977
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report describes the collection and analysis of data related to the behavior of the wake vortices of departing aircraft. The test site was located on the departure end of Runway 23L at Toronto International Airport, Toronto, Ontario, Canada. Three arrays of Ground Wind Vortex Sensing Systems and one Monostatic Acoustic Vortex Sensing System were used to detect, track and measure the strength of the vortices.

The data were analyzed to determine vortex lifetimes, transport characteristics and decay mechanism.

The results of the data analysis were used to generate an elliptical wind rose criterion similar to that used in the Vortex Advisory System for reduction in interarrival aircraft spacings.

Appendix A contains the results of a series of measurements on the Vortices generated by a Boeing Vertol 114 (H47 Chinook) helicopter.

17. Key Words	18. Distribution Statement
Vortex Sensing Tests, Acoustic Sensors, Wind Sensors, Aircraft Wake Vortices	DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	216	

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Technical Report Documentation Page

1. Report No. FAA-RD-78-150	2. Government Accession No. AD-A072793	3. Recipient's Catalog No.
4. Title and Subtitle HELICOPTER AIR TRAFFIC CONTROL OPERATIONS		5. Report Date May 1979
		6. Performing Organization Code SPD
7. Author(s)		8. Performing Organization Report No. T 79 ES 06 U
9. U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA78WAI-936
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration 800 Independence Avenue, S.W Washington, D.C. 20591		13. Type of Report and Period Covered Final Report, Task One
		14. Sponsoring Agency Code ARD-706
15. Supplementary Notes		

16. Abstract

The problems which inhibit the integration of IFR operations in the ATC system were examined, and recommendations were made to resolve these problems. Revisions in TERPS criteria and in the ATC Handbook are necessary, to minimize interference between fixed-wing and rotary-wing aircraft. The use of 2 nm radar separation between IFR helicopters in terminal areas is recommended to increase capacity by reducing the time interval between helicopter approaches to a value consistent with the time interval between fixed-wing approaches. Helicopters have a special need for low-altitude RNAV capability and the ATC system needs to be better adapted to handle the random route traffic that helicopters will generate in exploiting their special capabilities. To this end, it is recommended that the FAA develop software to call up and display, on the ATC PPI, random waypoints and connecting routes, on an as-needed basis.

Helicopters operating offshore and in remote areas are often beyond the coverage of surveillance radar, thus requiring the use of procedural control. They also operate below the coverage of VHF communications and VOR/DME, requiring alternate types of systems, several of which are recommended. The need for special controller training in procedural control, and in helicopter characteristics and limitations was made apparent during the study.

17. Key Words Helicopter Flight Operations, Helicopter ATC, Helicopter Flight Operations Costs, Communications Systems, Navigation Systems, Surveillance Systems		18. Distribution Statement Document is available to the public through the National Technical Information Service Springfield, VA 22161	
19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages [illegible]	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-78-157	AD-A068397	

4. Title and Subtitle
Review of Airworthiness Standards for Certification of Helicopters for Instrument Flight Rules (IFR) Operation

5. Report Date
February 1979

6. Performing Organization Code
SSED/FSD

7. Author(s)
J. J. Traybar, D. L. Green and A. G. DeLucien

8. Performing Organization Report No.
PAR-007-79

9. Performing Organization Name and Address
PACER Systems, Inc. (Suite 510)
1755 S. Jefferson Davis Highway
Arlington, VA 22202

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DOT-FA77WA-3966

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20591

13. Type of Report and Period Covered
Final Report
April 1977 to June 1978

14. Sponsoring Agency Code
FAA/ARD-530

15. Supplementary Notes

16. Abstract
This report reviews the Airworthiness Standards for Certification of Helicopters for Instrument Flight Rules Operation. It specifically reviews the Interim Criteria, Federal Aviation Regulations, Advisory Circulars and other pertinent documents associated with the certification of Helicopters for Instrument Flight. A review of current technology, existing data applicable to IFR helicopter operation and certification procedures is accomplished. Identification of specific airworthiness requirements for helicopters operating in IFR conditions is studied and special attention is given to aircrew manning configurations, pilot flight-control workloads, helicopter trim, static stability, dynamic stability, handling qualities, analysis of time history data and documentation procedures, augmentation systems, autopilots and a review of certain flight test techniques. An analysis was made of the numerous helicopters recently certified for IFR flight in order to establish the various systems utilized including avionics systems, display systems and autopilot type systems. Special emphasis was centered on the study of the most critical IFR flight phases depicted by high workload cruise conditions and marginal stability conditions due aft c.g. conditions, descent, and high climb rate conditions during IFR approaches and missed approaches for Category I procedures.

17. Key Words	18. Distribution Statement
HELICOPTER: AIRWORTHINESS STANDARDS FOR IFR CERTIFICATION, CRITERIA, HANDLING QUALITIES, STABILITY AND CONTROL	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

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Technical Report Documentation Page

1. Report No. FAA-RD-79-59

2. Government Accession No. AD-A072118

3. Recipient's Catalog No.

4. Title and Subtitle
POWERED-LIFT AIRCRAFT HANDLING QUALITIES IN THE PRESENCE OF NATURALLY-OCCURRING AND COMPUTER-GENERATED ATMOSPHERIC DISTURBANCES

5. Report Date May 1979

6. Performing Organization Code

7. Author(s) Wayne F. Jewell, Warren F. Clement
LCOL Thomas C. West, USA (Ret.), Dr. S.R.M. Sinclair

8. Performing Organization Report No. STI-TR-1099-3

9. Performing Organization Name and Address
Systems Technology, Inc.
2672 Bayshore-Frontage Road, Suite 505
Mountain View, California 94043

10. Work Unit No. (TRAIS)

11. Contract or Grant No. DOT-FA77WA-3936, Mods 1 & 8

12. Sponsoring Agency Name and Address
Federal Aviation Administration
Washington, D. C. 20590

13. Type of Report and Period Covered
Final Report
5/11/77 through 4/26/79

14. Sponsoring Agency Code ARD-530

15. Supplementary Notes

16. Abstract

The results of a two-phased program to investigate powered-lift aircraft handling quality degradation due to both naturally-occurring and computer-generated atmospheric turbulence are presented and discussed. In Phase I an airborne simulator was used to simulate a powered-lift aircraft on final approach. The atmospheric conditions included calm air, moderate to heavy turbulence, and frontal-type wind shears. In Phase II a ground-based simulator with a moving cockpit and a colored visual display was used to represent the same powered-lift aircraft. During Phase II, the Dryden model of atmospheric turbulence was used as well as the naturally-occurring wind profiles recorded during Phase I.

Analysis of the data showed that the handling quality assessments obtained in the airborne and ground-based simulators were similar, but wind shear was responsible for more of the differences than turbulence. The comparison of the handling quality assessments and selected measures of combined pilot-vehicle performance obtained with the naturally-occurring and computer-generated turbulences demonstrate that the Dryden model can yield optimistic ratings of airplane handling qualities and an optimistic estimate of combined pilot-vehicle performance degradation in turbulent landing conditions.

17. Key Words
Atmospheric Turbulence
Handling Qualities
Landing Simulation
Aircraft Landing
Wind Shear
Flight Tests
Powered Lift

18. Distribution Statement
Document is available to the U. S. public through the National Technical Information Service, Springfield, Virginia 22161.

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-79-64	AD-A072758	

4. Title and Subtitle	
Workload and the Certification of Helicopters for IFR Operation	5. Report Date: June 1979
	6. Performing Organization Code: SSED/FSD
7. Author(s): A.G. DeLucien, D.L. Green, S.W. Jordan and J.J. Traybar	8. Performing Organization Report No.: PAR-508-78-3
9. Performing Organization Name and Address: PACER Systems, Inc. 1755 S. Jefferson Davis Highway Arlington, VA 22202	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DOT-FA77WA-3966
12. Sponsoring Agency Name and Address: U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, DC 20591	13. Type of Report and Period Covered: Final Report July 1978 to June 1979
	14. Sponsoring Agency Code: FAA/ARD-530

15. Supplementary Notes

This work was accomplished under modification No. 2 (effective date July 18, 1978; requisition/purchase request No. LGR-8-5518) of contract No. DOT-FA77WA-3966

16. Abstract

A review was made of the Interim Criteria, Federal Aviation Regulations, Advisory Circulars and other pertinent Documents associated with certification of Helicopters for instrument flight. A review of publications pertaining to workload definitions and evaluation, applicable to IFR helicopter operations was accomplished. The report identifies the role of aircrew workload in the IFR certification process and develops a rationale to allow determination of that portion of a pilot's attention and effort available for aircraft control. Performance objectives for required maneuvers are delineated and the interdependence of performance and workload is identified. Workload/performance implications for single and dual pilot IFR operations are reviewed. A series of flight maneuver patterns for use as IFR certification assessment tools is developed. A flying qualities workload evaluation scheme is offered for use in the FAA certification process for IFR approval of helicopters.

17. Key Words	18. Distribution Statement
HELICOPTER: PILOT WORKLOAD, IFR HANDLING QUALITIES, FAA CERTIFICATION FOR IFR OPERATIONS.	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	126	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA RD-79-99	AD-A077900	

4. Title and Subtitle	
AIRBORNE RADAR APPROACH SYSTEM FLIGHT TEST EXPERIMENT	5. Report Date October 1979
	6. Performing Organization Code
7. Author(s) Larry D. King and Richard J. Adams	8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control, Inc. (Vt) 1801 Page Mill Road Palo Alto, California 94304	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FA79WA-4293
	13. Type of Report and Period Covered Final Report
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591	14. Sponsoring Agency Code

15. Supplementary Notes Prepared by:
Champlain Technology Industries, A Division of Systems Control, Inc. (Vt)
A Subsidiary of Systems Control, Palo Alto, California

16. Abstract

This report presents the results of a comprehensive flight test experiment of an Airborne Radar Approach (ARA) system. The tests were performed within a 60 nautical mile radius of NAFEC in Atlantic City, N.J. The test environment involved three distinct sites: airport, remote and offshore. The test aircraft was a NASA CH53A helicopter manufactured by Sikorsky Aircraft and currently based at NAFEC. The test period was from July 1978 to December 1978. Flight tests for ARA accuracy and procedures development were performed in both skin paint (and passive reflector) and single beacon radar operating modes. The flight test profiles and procedures were developed for the following reasons: 1) to assist the FAA and the user community in developing and certifying standard ARA procedures, associated weather minimums and obstacle clearance requirements; 2) to define and quantify specific ARA system functions and characteristics for use in a Minimum Operational Performance Standards (MOPS) document.

The primary conclusions of this flight test experiment were: the Airborne Radar Approach System tested performed satisfactorily from both an accuracy and an operational viewpoint in the single beacon mode for all three airspace environments; the ARA performance in the skin paint mode showed two significant problems, 1) distinguishing landside targets was quite difficult and could cause operational problems, 2) offshore targets such as oil rigs provide bright returns but are not distinguishable from boats, lighthouses and buoys; the ARA performance in the reflector mode showed that very large reflector cross sections are required to provide positive target identification.

Further flight experiments are planned to evaluate additional radar operating modes such as combined skin paint and beacon modes, and techniques of cockpit display to aid the pilot in his "track keeping" function.

17. Key Words	18. Distribution Statement
Airborne Radar Approach (ARA) Single Beacon Skin Paint Passive Reflector MOPS	This Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

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1. Report No. FAA-RD-79-123	2. Government Accession No. AD-A082026	3. Recipient's Catalog No.
4. Title and Subtitle TEST AND EVALUATION OF AIR/GROUND COMMUNICATIONS FOR HELICOPTER OPERATIONS IN THE OFFSHORE NEW JERSEY, BALTIMORE CANYON OIL EXPLORATION AREA		5. Report Date January 1980
		6. Performing Organization Code
7. Author(s) James J. Coyle		8. Performing Organization Report No. FAA-NA-79-22
9. Performing Organization Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 045-390-190
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration System Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Interim May 1978 - August 1979
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Helicopter instrument flight rules (IFR) operations in the offshore oil drilling areas are creating a need for low-level extended range air/ground (A/G) communications. This report describes the communications equipment and concepts used for helicopter IFR operations in the offshore New Jersey, Baltimore Canyon oil exploration area. Various types of very high frequency (VHF) high-gain directional antenna arrays were installed and flight tested to determine the degree of A/G communications coverage provided. Both the flight test data and more than 1 year of operational experience have shown that reliable A/G communications that can support IFR operations are obtainable throughout the offshore New Jersey oil exploration area by using high-gain directional antennas.

17. Key Words Air Traffic Control Communications VHF Extended Range Communications Helicopter IFR Communications	18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service. Springfield, Virginia 22161

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 24	22. Price

Technical Report Documentation Page

1. Report No. FAA-RD-80-17	2. Government Accession No. AD-A088024	3. Recipient's Catalog No.
4. Title and Subtitle NORTHEAST CORRIDOR USER EVALUATION		5. Report Date April 1980
		6. Performing Organization Code
7. Author(s) Joseph Harrigan		8. Performing Organization Report No. FAA-NA-80-13
9. Performing Organization Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 045-390-130
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Interim July 1979 - November 1979
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report describes an evaluation of the Northeast Helicopter Corridor Routes (NEC). The Northeast Corridor is an experimental route between Boston and Washington, D.C., consisting of two, one-way, reduced width airways designed expressly for helicopter operations. The evaluation is a joint effort of the Federal Aviation Administration (FAA) and the Helicopter Association of America (HAA). The data being gathered is in the form of data extraction tapes from Automated Radar Terminal Service (ARTS) equipped air traffic control (ATC) facilities along the routes and flight logs submitted by the helicopter pilots after each corridor test flight. The test flights are being made as cooperating corporate helicopter operators fly the corridor in the course of their normal operations.

The data collection phase of this evaluation began July 15, 1979, and will continue until July 15, 1980.

17. Key Words Northeast Corridor Helicopter IFR Area Navigation		18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 39	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-18	AD-A084015	

4. Title and Subtitle FLIGHT EVALUATION OF A RADAR CURSOR TECHNIQUE AS AN AID TO AIRBORNE RADAR APPROACHES	5. Report Date March 1980
	6. Performing Organization Code
7. Author(s) J. Perez, Major, USAF	8. Performing Organization Report No. FAA-NA-80-8
9. Performing Organization Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. 045-390-130
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	13. Type of Report and Period Covered Interim July 1979 - August 1979
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report presents preliminary results of a flight test evaluation of a radar cursor technique to be used as an aid in acquiring and tracking the desired ground track during airborne radar approaches. The test was performed using a Sikorsky CH-53A helicopter on loan from NASA and based at NAFEC. The airborne radar system used was a BENDIX RDR-1400A modified to electronically produce a radar cursor display of course error. Airborne radar approaches were made to an offshore and an airport test environment located within a 60 naucical mile radius of NAFEC. Systems Control, Inc.(SCI), provided contractor services in the areas of test planning, data reduction, and final report preparation. The specific purpose of the test was to evaluate the practical utility of the radar cursor as an aid to performing airborne radar approaches. The preliminary conclusion of this test was that the use of the radar cursor improved course acquisition and ground tracking significantly with pilotage errors and total system cross-track errors reduced by one-half or better. The radar cursor technique showed potential in reducing airspace requirements for airborne radar approaches. SCI is presently completing data reduction and analysis and will publish a final report in the near future.

17. Key Words	18. Distribution Statement
Helicopter Instrument Flight Rules (IFR) Airborne Radar Approach (ARA) Weather Radar System Radar Cursor Technique Offshore Approach Beacon Approach	Document is available to U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	35	

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Technical Report Documentation Page

1. Report No. FAA-RD-80-20	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle HELICOPTER COMMUNICATIONS SYSTEM STUDY		5. Report Date February 1980
		6. Performing Organization Code
7. Author(s) M. White & D. Swann		8. Performing Organization Report No. 1575-01-2-2162
9. Performing Organization Name and Address ARINC Research Corporation 2551 Riva Road Annapolis, Maryland 21401		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA78WAI-939/DAAB07-78-A-6606
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Washington, D.C. 20591		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report examines the communications requirements of helicopters operating in the National Airspace System in the 1985-1990 time frame. The technical options that exist or are forecast to exist in that time frame are examined for suitability in meeting the requirements, and their pros and cons are discussed. A research plan is formulated for developing the required capabilities.

17. Key Words helicopter, communication, navigation, surveillance, loran-C	18. Distribution Statement Unlimited

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 68	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-22	AD-A103374	

4. Title and Subtitle	5. Report Date
AIRBORNE RADAR APPROACH	April 1980
	6. Performing Organization Code
7. Author(s) C. Mackin	8. Performing Organization Report No. FAA-NA-79-56
9. Performing Organization Name and Address Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. 045-390-130
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	13. Type of Report and Period Covered Final Report September 1978-February 1979 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A flight test series investigating the airborne radar approach (ARA) for helicopters is discussed. Passive and active target enhancement methods and their relative merits are examined. A description of systems and methods involved in the ARA are presented along with subjective insights and conclusions. It is concluded that the ARA is a practical approach aid in the absence of conventional navigation aids (NAVAID's) subject to certain limitations as discussed herein.

17. Key Words	18. Distribution Statement
Helicopter Instrument Flight Rules Weather Radar Transponder Beacon Offshore Corner Reflector	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	46	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-24	AD-A088892	

4. Title and Subtitle	5. Report Date
ICING CHARACTERISTICS OF LOW ALTITUDE, SUPERCOOLED LAYER CLOUDS.	May, 1980
	6. Performing Organization Code
7. Author's)	8. Performing Organization Report No.
Richard K. Jeck	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Naval Research Laboratory 4555 Overlook Avenue, SW Washington, D.C. 20375	11. Contract or Grant No. FA79WAI-020
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591	Interim Report February to October, 1980
	14. Sponsoring Agency Code FAA/ARD-413

15. Supplementary Notes

16. Abstract

A limited amount of new data has been obtained on the icing environment during initial airborne measurements aimed at developing environmental icing criteria for use in certifying helicopters for flight into icing conditions. Supercooled cloud characteristics are reported for 12 icing events encountered at temperatures from -10°C to 0°C at altitudes from 3500 to 6500 ft above the surface of Lake Erie and Lake Michigan. Recorded droplet size spectra from a Particle Measuring Systems' Axially Scattering Probe (ASSP) were used to compute droplet mass (volume) median diameter (MMD) and, in addition to a Johnson-Williams LWC Indicator, the liquid water content (LWC). A review of available historical data from 1944-1950, upon which the atmospheric icing standards of Appendix C, FAR 25 were based, reveals that data obtained from measurements of ice accretion on multidiameter cylinders are subject to a number of significant errors of both signs. These probable errors, which will continue to be evaluated, may be responsible for the conclusions that 1) the historical LWC values are generally larger than those observed in the flights described in this report, 2) the historical MMDs appear to be generally too small for all values of LWC and 3) the historical droplet size distributions are unreliable, as is acknowledged in the later historical literature.

17. Key Words	18. Distribution Statement
Aircraft Icing, Airborne Measurements, Liquid Water Content, Stratus Clouds, Helicopter Icing, Supercooled Clouds, Dropsize Distribution	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	71	

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Technical Report Documentation Page

1. Report No.
NA-80-34-LR

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
Survey of Heliport IFR Lighting and Marking Systems

5. Report Date
April 1980

6. Performing Organization Code

8. Performing Organization Report No.
NA-80-34-LR

7. Author(s)
Thomas H. Paprocki

9. Performing Organization Name and Address
Federal Aviation Administration
National Aviation Facilities Experimental Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

13. Type of Report and Period Covered
Letter Report

12. Sponsoring Agency Name and Address
Federal Aviation Administration
Office of Airports Standards
Washington, D.C. 20591

14. Sponsoring Agency Code
AAS-100

15. Supplementary Notes

16. Abstract

The purpose of this effort, a preliminary to design and testing of Heliport Instrument Flight Rules (IFR) Lighting and Marking System, was to conduct a review of the state-of-the-art development of such systems. Visits were made to organizations presently conducting IFR helicopter operations in the U.S. and abroad. Inquiries were made as to the types of IFR helicopter operations being conducted and the types of lighting and marking systems used.

In summary, the conduct of the IFR lighting and marking survey had revealed that there are, at present, virtually no visual guidance systems in being or planned that are capable of supporting either nonprecision or precision helicopter approaches for landing at helipads or heliports. Thus, the developmental work to be accomplished at NAFEC within the framework of the All Weather Heliport Lighting and Marking Project will have to be done without benefit or prior operational experience.

17. Key Words
Heliport Lighting
Instrument Flight Rules
Helicopter

18. Distribution Statement
Document is on file at the NAFEC Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	8	

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-47	AD-A091637	
4. Title and Subtitle FLIGHT TEST INVESTIGATION OF LORAN-C FOR EN ROUTE NAVIGATION IN THE GULF OF MEXICO		5. Report Date September 1980
		6. Performing Organization Code
7. Author(s) Robert Pursel		8. Performing Organization Report No. FAA-CT-80-18
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 045-390-130
12. Sponsoring Agency Name and Address U.S. Department of Transportation Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Final
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Flight tests of a long range navigation (LORAN-C) airborne navigator were conducted in the Gulf of Mexico oil exploration and production area. Two systems were installed in a CV-580 aircraft to examine simultaneously the performance from two different LORAN-C triads. Four separate test routes were flown over a period of 3 days. These routes covered the eastern, central, and western test areas, and an overland route from Houston, Texas, to Lafayette, Louisiana. An inertial navigation system (INS) was used as a position reference standard. The INS data were updated to correct for drift. Accuracy of the position reference from the corrected INS data was ±0.3 nautical miles (nmi). The flight test data collected indicated that both the Malone, Raymondville, Jupiter and the Malone, Raymondville, Grangeville triads provided en route LORAN-C navigation capability which met Federal Aviation Administration (FAA) Advisory Circular AC-90-45A accuracy requirements except when operating near the baseline extension of the Malone-Grangeville baseline when using the Malone, Raymondville, Grangeville triad.

17. Key Words	18. Distribution Statement
LORAN-C En Route Navigation Radio Navigation System	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No.
FAA-RD-80-58

2. Government Accession No.
AD-A090052

3. Recipient's Catalog No.

4. Title and Subtitle
Study of Helicopter Performance and
Terminal Instrument Procedures

5. Report Date
June 1980

6. Performing Organization Code
SSED/FSG

8. Performing Organization Report No.

7. Author(s) A.G. DeLucien, D.L. Green, H.R. Price, and F.D. Smith

9. Performing Organization Name and Address
PACER Systems, Inc.
1755 South Jefferson Davis Highway
Arlington, VA 22202

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DOT-FA-79WAI-019

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20591

13. Type of Report and Period Covered
Final Report

14. Sponsoring Agency Code
FAA/ARD-330

15. Supplementary Notes

16. Abstract

In an effort to provide data needed to examine the feasibility of new procedures and criteria for terminal instrument procedures, this study effort addresses helicopter IFR operations in two parts. First, it documents, in a collective sense, the IMC and VMC performance capabilities of currently IFR-certified helicopters. A number of proposed helicopter procedures are analyzed for their suitability for futher consideration or experimental testing, considering the current helicopter parametric performance envelopes. Second, helicopter instrument procedures are addressed in the long-term sense and recommendations are offered for development of post-1985 operations.

17. Key Words
Helicopter, Pilot Workload, IFR
Handling Qualities, TERPS
Helicopter Performance

18. Distribution Statement
This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22162

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No. FAA-RD-80-59	2. Government Accession No. AD-A088150	3. Recipient's Catalog No.
4. Title and Subtitle Helicopter Terminal Instrument Procedures (TERPS) Development Program		5. Report Date June 1980
		6. Performing Organization Code
7. Author(s) Helicopter Systems Branch (ARD-330)		8. Performing Organization Report No.
9. Performing Organization Name and Address Federal Aviation Administration Systems Research and Development Service Helicopter Systems Branch Washington, D.C. 20590		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Program Plan
		14. Sponsoring Agency Code ARD-330

15. Supplementary Notes

16. Abstract

The Helicopter TERPS Development Program is designed to collate and coordinate all inputs received from government-sponsored and other projects which relate to helicopter TERPS in order to: assure that data generated by each project is developed, coordinated and applied in such a way as to avoid duplication of effort while achieving results in minimum time. It describes a development program whose objective is to develop criteria which will maximize the efficiency of terminal area and enroute operations with helicopters, by applying the unique maneuver-performance capabilities of helicopters. It includes both a near-term and long-term review of TERPS, both of which are expected to generate modification of the U.S. Standard for Terminal and Enroute Instrument Procedures and the criteria and procedures contained therein. The FAA, other Federal Government agencies, and organizations participating in this effort are identified. Program management responsibilities are addressed and a program schedule with milestones is presented.

17. Key Words Helicopter, TERPS, IFR, Terminal Environment, Air Traffic Control	18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	6[illegible]	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-60	AD-A088626	

4. Title and Subtitle	5. Report Date
Airborne Radar Approach Flight Test Evaluating Various Track Orientation Techniques	June 1980
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s) Larry D. King	
9. Performing Organization Name and Address Systems Control, Inc. (Vt) 1801 Page Mill Road Palo Alto, California 94304	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FA79WA-4293
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591	13. Type of Report and Period Covered Draft Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

Champlain Technology Industries, A Division of Systems Control, Inc. (Vt)
A subsidiary of Systems Control, Palo Alto, California

16. Abstract

This comprehensive report presents the results of a flight test experiment of an Airborne Radar Approach (ARA) System utilizing various track orientation techniques and operational modes. The tests were performed in the immediate area of NAFEC in Atlantic City, N.J. The test environment involved the airport terminal area and offshore sites. The test aircraft was a NASA CH53A helicopter manufactured by Sikorsky Aircraft and currently based at NAFEC. The test period was from January 1979 to February 1979 and from June 1979 to August 1979. Flight tests for ARA accuracy and procedures development were performed in six distinct operational modes. These were as follows: beacon w/cursor, multiple beacon, skin paint, skin paint w/cursor, combined and beacon-only modes. The specific program objectives can be summarized as follows: 1) to evaluate the ability of the radar operator to guide an aircraft along a predetermined path using various track orientation techniques, namely: the cursor and multiple beacon techniques; 2) to assist the FAA in developing and certifying standard ARA procedures and weather minimums; 3) to define and quantify specific ARA system functions and characteristics for use in a Minimum Operational Performance Standards (MOPS) document.

The primary conclusions of this flight test experiment were: the ARA system performed satisfactorily from both an accuracy and an operational viewpoint in all six operational modes, the ARA performance utilizing the track orientation techniques showed marked decrease in the overall Total System Cross Track (TSCT) and Flight Technical Error (FTE) quantities; the cursor and multiple beacon techniques also eliminated the tendency to "home" to station; in the skin paint mode distinguishing offshore targets such as lighthouses from ships and other surface objects is virtually impossible.

17. Key Words	18. Distribution Statement
Airborne Radar Approach (ARA) Beacon w/cursor Skin Paint Multiple Beacon MOPS	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	181	

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Technical Report Documentation Page

1. Report No. FAA-RD-80-64	2. Government Accession No. AD-A093654	3. Recipient's Catalog No.

4. Title and Subtitle
A Piloted Simulator Investigation of Static Stability and Stability/Control Augmentation Effects on Helicopter Handling Qualities for Instrument Approach

5. Report Date

6. Performing Organization Code

7. Author(s)
J.V. Lebacqz, R.D. Forrest, R.M. Gerdes

8. Performing Organization Report No.
NASA TM-81188

9. Performing Organization Name and Address
National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California 94035

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
Federal Aviation Administration
System Research and Development Service
Washington, D.C. 20591

13. Type of Report and Period Covered
Technical Memorandum

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A motion-based simulator was used to compare the flying qualities of three generic single-rotor helicopters during a full-attention-to-flight control task. Terminal-area VOR instrument approaches were flown with and without turbulence. The objective of this NASA/FAA study was to investigate the influence of helicopter static stability in terms of the values of cockpit control gradients as specified in the existing airworthiness criteria, and to examine the effectiveness of several types of stability control augmentation systems in improving the instrument-flight-rules capability of helicopters with reduced static stability. Two levels of static stability in the pitch, roll, and yaw axes were examined for a hingeless-rotor configuration; the variations were stable and neutral static stability in pitch and roll, and two levels of stability in yaw. For the lower level of static stability, four types of stability and control augmentation were also examined for helicopters with three rotor types: hingeless, articulated, and teetering. Pilot rating results indicate the acceptability of neutral static stability longitudinally and laterally and the need for pitch-roll attitude augmentation to achieve a satisfactory system.

17. Key Words
Helicopter
Handling Qualities
Instrument Approach

18. Distribution Statement
This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	394	

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-80	AD-A088151	

4. Title and Subtitle	5. Report Date
Helicopter Northeast Corridor Operational Test Support	June 1980
	6. Performing Organization Code
7. Author(s): Glen A. Gilbert	8. Performing Organization Report No.
9. Performing Organization Name and Address: Helicopter Association of America, 1156 15th St. N. W., Washington, D. C. 20005	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FA79-WA-4303
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Aviation Administration, 800 Independence Avenue S. W., Washington, D. C. 20591	13. Type of Report and Period Covered: Final Report, April 1979 - June 1980
	14. Sponsoring Agency Code: ARD-330

15. Supplementary Notes The Helicopter Northeast Corridor Evaluation was conducted by the Helicopter Systems Branch of the Navigation and Landing Division under the direction of Raymond J. Hilton, Program Manager. This report and a companion report from the FAA Technical Center entitled "Northeast Corridor Operational User Evaluation", RD 80-17, reflect the results of the evaluation.

16. Abstract

With the growing importance of helicopters to the national air transportation system, a demand is developing for more IFR (virtually all-weather) helicopter capability. At the same time, it is essential that helicopters be able to take advantage of their unique features and operate within the common ATC system without conflict to or from conventional fixed wing air traffic. A "test bed" operation was established progressively by the FAA in cooperation with the HAA during the period 1975-1978 to develop real world applications of these and other helicopter operational concepts in the Northeast Corridor (NEC) of the United States. During mid-1979 to early 1980 a nine month controlled NEC test and evaluation project was carried out jointly by the HAA and the FAA. This HAA report describes the methodology and procedures followed, results obtained during the controlled test period, and conclusions and recommendations reached. The complementary FAA Technical Center report referred to in item 15 above will be issued separately.

17. Key Words	18. Distribution Statement
Helicopter; Radar tracking; Northeast Corridor (NEC); area navigation (RNAV); Flight Technical Error (FTE); In-flight/Post-flight data logs; Point-in-Space (PIS); HSVFR	Document is available to U. S. public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	76	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-85	AD-A089430	

4. Title and Subtitle	5. Report Date
Proposed ATC System for the Gulf of Mexico Helicopter Operations Development Program	November 1979
	6. Performing Organization Code: SA-3
7. Author(s): D. J. Freund, T. K. Vickers	8. Performing Organization Report No.
9. Performing Organization Name and Address: Vitro Laboratories Division, Automation Industries, Inc., 14000 Georgia Avenue, Silver Spring, Md. 20910	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DOT-FA79WA-4279
12. Sponsoring Agency Name and Address: Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Helicopter Systems Branch, Washington, D.C. 20590	13. Type of Report and Period Covered: Final Report
	14. Sponsoring Agency Code: ARD-330

15. Supplementary Notes

This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch under the direction of Raymond J. Hilton, Program Manager.

16. Abstract

A helicopter ATC system for the Gulf of Mexico is set forth. It embodies a concept of evolutionary growth in four phases as follows:

Phase 1, The Present System (period of use: 1980). IFR navigation is obtained primarily with Loran-C, or VLF/OMEGA. Back-up systems are ADF and Airborne Weather Radar. VOR/DME is used over land. ATC is by procedural control and separation standards because no radar or other surveillance system is available off shore.

Phase 2, LOFF (Loran-C Flight Following)(Period of Evaluation:1981). The LOFF system is placed in operation for experimentation and evaluation. While ATC is still performed by procedural control, LOFF will assist ground controllers by reducing workload, improving flexibility, etc. Experiments will also be performed on secondary radar systems (ATCRBS & VLATME) to provide surveillance.

Phase 3, Augmented LOFF (Period of use: 1983 and beyond). IFR helicopters will be able to fly direct,offset or segmented RNAV routes. ATC will be essentially equivalent to the NAS. Navigation by Loran-C will expand. Surveillance will be by LOFF and/or secondary radar. Area of control will be 1,500' tc 10,000' over entire Gulf.

Phase 4, RNAV Traffic Control (Period of use: 1985 and beyond). IFR helicopters will be able to use any of a number of certified navigation systems. ATC systems will adapt to varying accuracies of these systems. ATC will be based on surveillance provided by aircraft reporting of position information and/or secondary radar. Separation standards will be reduced and be equivalent to Northeast Corridor.

17. Key Words	18. Distribution Statement
Helicopter ATC System Helicopter Gulf of Mexico ATC System	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-86	AD-A089435	

4. Title and Subtitle

Recommendations for Short-Term Simulation of ATC Concepts
Helicopter Operations Development Program

5. Report Date: February 1980

6. Performing Organization Code: SA-3

8. Performing Organization Report No.

7. Author(s)

D. J. Freund, T. K. Vickers

9. Performing Organization Name and Address

Vitro Laboratories Division
Automation Industries, Inc.
14000 Georgia Avenue
Silver Spring, Md. 20910

10. Work Unit No. (TRAIS)

11. Contract or Grant No.: DOT-FA79WA-4279

12. Sponsoring Agency Name and Address

Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Helicopter Systems Branch
Washington, D.C. 20590

13. Type of Report and Period Covered: Final Report

14. Sponsoring Agency Code: ARD-330

15. Supplementary Notes

This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch under the direction of Raymond J. Hilton, Program Manager.

16. Abstract

A number of recommendations from a previous helicopter air traffic control (ATC) study (See Report FAA-RD-78-150) were examined. Those which appeared to have potential for early implementation were selected for further testing. The selected recommendations included: (1) dual-fix holding patterns to save airspace; (2) speed control procedures and short approach paths to save fuel; (3) various methods of reducing separation in order to increase airport or heliport capacity. Under item 3 above, a rationale for utilizing existing parallel approaches of helicopters and CTOL aircraft was presented for consideration.

Extensive use of flight simulation and ATC simulation was recommended in order to reduce the time and cost of evaluating the potential improvements. The steps of the recommended simulation program were arranged in the order of ascending cost, to learn as much as possible about the subject as quickly as possible and to weed out or revise impractical solutions before they reach a more expensive stage of evaluation or development. A detailed simulation program was prepared using a modified factorial design in order to isolate the effects of changes in various parameters.

17. Key Words	18. Distribution Statement
Helicopter, air traffic control (ATC), simulation, holding patterns, approach procedures, separation standards,	Document is available to the U.S. public through the National Technical Information Service, Springfield VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	43	

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-87	AD-A089407	

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code / 8. Performing Organization Report No.
PRELIMINARY TEST PLANS OF ATC CONCEPTS FOR LONGER TERM IMPROVEMENT (HELICOPTER OPERATIONS DEVELOPMENT PROGRAM)	5. May 1980 6. SA-3 8.
7. Author(s) D.J. Freund, T.K. Vickers	
9. Performing Organization Name and Address Vitro Laboratories Division Automation Industries, Inc. 14000 Georgia Avenue Silver Spring, MD 20910	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DOT-FA79WA-4279
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Helicopter Systems Branch Washington, D.C. 20590	13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code ARD-330

15. Supplementary Notes

This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch under the direction of Raymond J. Hilton, Program Manager.

16. Abstract

Test and simulation planning is documented for longer-term improvements in helicopter ATC concepts, which are classified into the following categories:

1. Offshore Route Structure in the Gulf of Mexico
2. Secondary Radar
3. Analysis of Navigation Errors in the Gulf
4. Offshore Surveillance and Communications to 300 NM Range
5. Real-Time Reporting of Aircraft-Derived Position
6. VHF Communications Study in the CONUS
7. ATC Implications of Alternate Airports for Helicopters
8. Wake Vortex Separation

17. Key Words	18. Distribution Statement
Longer Term ATC Concepts for Helicopters Helicopter ATC Concepts	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA, 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	49	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-88,1	AD-A089521	

4. Title and Subtitle
Recommended Short Term ATC Improvements for Helicopters
Vol. I Summary of Short Term Improvements
Vol. II Recommended Helicopter ATC Training Material
Vol. III Operational Description of Experimental Loran Flight Following (LOFF) in the Houston Area

5. Report Date Vol. I August 1979
Vol. II & III -- April 1980

6. Performing Organization Code SA-3

8. Performing Organization Report No.

7. Author(s)
Tirey K. Vickers, D. J. Freund

9. Performing Organization Name and Address
Vitro Laboratories Division
Automation Industries, Inc.
14000 Georgia Avenue
Silver Spring, Md. 20910

10. Work Unit No. (TRAIS)

11. Contract or Grant No. DOT-FA79WA-4279

13. Type of Report and Period Covered Final Report

12. Sponsoring Agency Name and Address Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Helicopter Systems Branch
Washington, D.C. 20590

14. Sponsoring Agency Code ARD-330

15. Supplementary Notes
This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch under the direction of Raymond J. Hilton, Program Manager.

16. Abstract

The recommended Short Term ATC Improvements for Helicopters are documented in three volumes, i.e.:

- Vol. I is a summary report of all improvements studied. Improvements are categorized as to those that can be recommended for immediate operational consideration or use and those that require limited short term simulation or test.

  The recommendations for immediate use include: (1) Helicopter ATC training material, (2) Operational Description of LOFF, (3) Recommendations concerning military training routes and (4) Survey data for use in Gulf communications and route structure planning.

  The recommendations for short term simulation include: (1) Dual waypoint holding patterns, (2) other holding patterns and (3) shortened entry procedures for intercepting final approach path.
- Vol. II is the complete training material for helicopter ATC. It contains major sections on Helicopter Capabilities and Limitations, on Helicopter Navigation and on Helicopter Control Procedures.
- Vol. III is the complete Operational Description of the Experimental Loran Flight Following (LOFF) in the Houston Area. It describes both airborne and ground components and states the objectives that are being sought in the experiment.

17. Key Words	18. Distribution Statement
Helicopter ATC, Helicopter Air Traffic Control, Helicopter ATC Controller Training, Loran Flight Following (LOFF) Helicopter Holding Patterns	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-88, II	AD-A089441	

4. Title and Subtitle: Recommended Short Term ATC Improvements for Helicopters
Vol. I Summary of Short Term Improvements
Vol. II Recommended Helicopter ATC Training Material
Vol. III Operational Description of Experimental Loran Flight Following (LOFF) in the Houston Area

5. Report Date: Vol. I August 1979; Vol. II & III - April 1980

6. Performing Organization Code: SA-3

7. Author(s): Tirey K. Vickers, D. J. Freund

8. Performing Organization Report No.:

9. Performing Organization Name and Address:
Vitro Laboratories Division
Automation Industries, Inc.
14000 Georgia Avenue
Silver Spring, Md. 20910

10. Work Unit No. (TRAIS):

11. Contract or Grant No.: DOT-FA79WA-4279

12. Sponsoring Agency Name and Address: Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Helicopter Systems Branch
Washington, D.C. 20590

13. Type of Report and Period Covered: Final Report

14. Sponsoring Agency Code: ARD-330

15. Supplementary Notes:
This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch under the direction of Raymond J. Hilton, Program Manager.

16. Abstract

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- Vol. III is the complete Operational Description of the Experimental Loran Flight Following (LOFF) in the Houston Area. It describes both airborne and ground components and states the objectives that are being sought in the experiment.

17. Key Words	18. Distribution Statement
Helicopter ATC, Helicopter Air Traffic Control, Helicopter ATC Controller Training, Loran Flight Following (LOFF) Helicopter Holding Patterns	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	81	

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Technical Report Documentation Page

1. Report No. FAA-RD-80-88,III	2. Government Accession No. AD-A089385	3. Recipient's Catalog No.
4. Title and Subtitle Recommended Short Term ATC Improvements for Helicopters Vol. I Summary of Short Term Improvements Vol. II Recommended Helicopter ATC Training Material Vol. III Operational Description of Experimental Loran Flight Following (LOFF) in the Houston Area		5. Report Date Vol. I August 1979 Vol. II & III - April 1980
		6. Performing Organization Code
7. Author(s) Tirey K. Vickers, D. J. Freund		8. Performing Organization Report No. SA-3
9. Performing Organization Name and Address Vitro Laboratories Division Automation Industries, Inc. 14000 Georgia Avenue Silver Spring, Md. 20910		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA79WA-4279
		13. Type of Report and Period Covered Final Report
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Helicopter Systems Branch Washington, D.C. 20590		14. Sponsoring Agency Code ARD-330

15. Supplementary Notes

This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch under the direction of Raymond J. Hilton, Program Manager.

16. Abstract

The recommended Short Term ATC Improvements for Helicopters are documented in three volumes, i.e.:

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- Vol. III is the complete Operational Description of the Experimental Loran Flight Following (LOFF) in the Houston Area. It describes both airborne and ground components and states the objectives that are being sought in the experiment.

17. Key Words Helicopter ATC, Helicopter Air Traffic Control, Helicopter ATC Controller Training, Loran Flight Following (LOFF) Helicopter Holding Patterns	18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

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UNCLASSIFIED	UNCLASSIFIED	31	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-107	AD-A091156	

4. Title and Subtitle	5. Report Date
Study of Heliport Airspace and Real Estate Requirements	August 1980
	6. Performing Organization Code: SSED/FSG
7. Author(s): A. G. DeLucien, F. D. Smith	8. Performing Organization Report No.: PAR-037-80
9. Performing Organization Name and Address: PACER Systems, Inc., Suite 510, 1755 South Jefferson Davis Highway, Arlington, VA 22202	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DOT-FA-79WAI-019
	13. Type of Report and Period Covered: Final Report, March 1980 to July 1980
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	14. Sponsoring Agency Code: FAA/ARD-330

15. Supplementary Notes

16. Abstract

This report documents the review and evaluation of real estate and airspace requirements as set forth in applicable U.S. heliport design criteria. International criteria are reviewed to discern their rationale for various requirements. Helicopter performance during normal and failure-state operations is analyzed. The suitability of current criteria is examined with respect to various operational profiles. Modifications to current criteria are suggested which would accommodate various operational requirements and varying levels of terminal instrument procedures capability. Recommendations include a revised heliport classification scheme with corresponding changes to real estate and airspace criteria for IFR operations; helicopter performance chart standardization for flight manuals with specific data requirements; consideration of obstacle clearance for failure-state operations; additional criteria for offshore facilities; and revised criteria for elevated heliports/ helipads.

17. Key Words	18. Distribution Statement
Helicopter, Heliport, Real Estate, Airspace, Obstacle Surfaces, Terminal Instrument Procedures, Criteria	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	148	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-CT-80-175		

4. Title and Subtitle	5. Report Date
LORAN-C Nonprecision Approaches in the Northeast Corridor	July 1980
	6. Performing Organization Code
7. Author(s) Frank Lorge	8. Performing Organization Report No. FAA-CT-80-175
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	13. Type of Report and Period Covered Project Plan
	14. Sponsoring Agency Code ARD-300

15. Supplementary Notes

16. Abstract

This flight test plan is designed to determine the suitability and accuracy of LORAN-C nonprecision approaches for helicopters in the Northeast Carridor. Results will be compared with Advisory Circular (AC) 90-45A requirements for total system accuracy. Conclusions will be drawn with regard to the accuracy of LORAN-C nonprecision approaches for helicopters. Specific objectives are:

a. To collect data on LORAN-C system errors to support decisions relative to possible certification of LORAN-C for nonprecision approaches in the Northeast Corridor.

b. To obtain specific operational data on performance of LORAN-C for nonprecision approaches and missed approaches in the Northeast Corridor.

c. To obtain data on flight technical error associated with LORAN-C nonprecision approaches.

d. To obtain data on area propagation anomalies in the Northeast Corridor.

e. To obtain performance and operational data on LORAN-C using various triad configurations for the 9960 LORAN chain.

f. To obtain data on LORAN-C signal strength and availability.

17. Key Words	18. Distribution Statement
LORAN-C Nonprecision Approaches Northeast Corridor Helicopter Flight Technical Error	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	25	

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Technical Report Documentation Page

1. Report No.: FAA-CT-80-210
2. Government Accession No.: AD-A094175
3. Recipient's Catalog No.:
4. Title and Subtitle: HELICOPTER ICING REVIEW
5. Report Date: September 1980
6. Performing Organization Code:
7. Author(s): A. A. Peterson and L. U. Dadone
8. Performing Organization Report No.: D210-11583-1
9. Performing Organization Name and Address:
Boeing Vertol Company
A Division of The Boeing Company
P.O. Box 16858
Philadelphia, Pennsylvania 19142
10. Work Unit No. (TRAIS):
11. Contract or Grant No.: DOT FA78WA-4258
12. Sponsoring Agency Name and Address:
U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405
13. Type of Report and Period Covered: Final Report, 30 Sept. 78 - 31 July 80
14. Sponsoring Agency Code:
15. Supplementary Notes:

16. Abstract

The development of techniques and criteria permitting the release of a helicopter into known (i.e., forecast) icing situations is actively being investigated by both military and civilian agencies through ongoing test programs and study efforts. As part of this overall effort, helicopter icing characteristics, available ice protection technology, and test techniques are discussed in this technical treatment. Recommendations are provided in the areas of icing certification procedures and icing research.

One of the key issues addressed in this report is the test environment, i.e., the use of inflight evaluation in natural icing only, or, the use of a simulated icing environment to supplement and/or expand the certification envelope. Involved in this issue is the shape (and extent) of the rotor ice (natural vs simulated) as it affects the aerodynamics and dynamics of the rotor system, together with the shedding characteristics as it affects the behavior and safety of the complete vehicle.

17. Key Words:
Helicopter Ice Protection
Icing Certification
Icing Environment
Icing Research
Rotor Icing

18. Distribution Statement:
Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report): Unclassified
20. Security Classif. (of this page): Unclassified
21. No. of Pages: 247
22. Price:

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Technical Report Documentation Page

1. Report No. FAA-RD-81-7-LR	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle: Three Cue Helicopter Flight Directors: An Annotated Bibligoraphy		5. Report Date: September 1981
		6. Performing Organization Code
7. Author(s): T. Pott, J.P. McVicker, H.W. Schlickenmaier		8. Performing Organization Report No. FAA-RD-81-7-LR
9. Performing Organization Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20590		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20590		13. Type of Report and Period Covered: Final Report
		14. Sponsoring Agency Code: ARD-300

15. Supplementary Notes

16. Abstract

The helicopter community has a need for adequate instruments for safe instrument flight. The three-cue flight director has been found to be suitable during Instrument Meteorological Conditions. With the increased use of flight directors by civil operators, questions have been raised regarding the collective command's (the third cue) sensing. A literature search was conducted to determine what work had been done with the collective display format.

17. Key Words: Helicopter, Flight Display, Flight Director, Instrument Flight Rules, Collective	18. Distribution Statement: Unlimited

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 23	22. Price

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Technical Report Documentation Page

1. Report No.
FAA-RD-81-9

2. Government Accession No.
AD-A101642

3. Recipient's Catalog No.

4. Title and Subtitle
Impact of Low Altitude Coverage Requirements on Air-Ground Communications

5. Report Date
March 31, 1981

6. Performing Organization Code

7. Author(s)
B. Magenheim

8. Performing Organization Report No.

9. Performing Organization Name and Address
AMAF Industries, Inc.
P.O. Box 1100
103 Sterrett Building
Columbia, Maryland 21044

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DOT-FA78WAI-830

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Final Report
Aug. 1980 - Mar. 1981

14. Sponsoring Agency Code
ARD 212

15. Supplementary Notes

16. Abstract
A representative area of Appalachia surrounding Charleston, West Virginia is analyzed in terms of existing helicopter traffic patterns and communications facilities. Traffic patterns were established from telephone interviews with pilots flying this area regularly. Communications coverage was established from computer generated coverage contours obtained from the Electromagnetic Compatability Analysis Center (ECAC) and verified by pilot interviews and one flight test (as reported by the FAA Technical Center). Techniques for improving coverage are discussed. These include two new remote communication outlets located in the mountains west and south of Beckley, W.Va., a high gain antenna at Charleston pointed in a southerly direction, the use of mobile radio telephone to permit pilots to access nearby telephone facilities when on the ground at a remote site, short range less than 150 miles, hf radio, and a discrete frequency for exclusive use by low-flying aircraft.

FAA activities directed at improving communications to helicopter traffic flying to and from offshore oil and gas platforms in the Gulf of Mexico is presented in an Appendix.

17. Key Words
Appalachia, Helicopters, Communications, Traffic

18. Distribution Statement
Document is available to the U.S. public through the National Technical Information Service, Springfield, Va. 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	98	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-81-27	AD-A105260	

4. Title and Subtitle
FLIGHT EVALUATION OF LORAN-C AS A HELICOPTER NAVIGATION AID IN THE BALTIMORE CANYON OIL EXPLORATION AREA

5. Report Date
May 1981

6. Performing Organization Code

7. Author(s)
William A. Lynn

8. Performing Organization Report No.
FAA-CT-80-53

9. Performing Organization Name and Address
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
045-390-130

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

13. Type of Report and Period Covered
Final Report
March - May 1979

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A series of flight tests were conducted from March through May 1979 to investigate the use of long range navigation (LORAN)-C as a helicopter navigation system in the offshore New Jersey Baltimore Canyon oil exploration area. Tests were flown aboard the Federal Aviation Adminstration (FAA) Technical Center's CH-53A using a Teledyne *Systems TDL-711 LORAN Micro-Navigator.* The purpose of the tests was to determine the accuracy and operational usability of LORAN-C for offshore en route navigation and nonprecision approaches. The total system accuracy met or exceeded the requirements of Advisory Circular (AC) 90-45A "Accuracy Requirements of Area Navigation Systems" for terminal and en route phases of flight, provided the proper LORAN triads were selected. The LORAN-C System did not meet AC 90-45A nonprecision approach accuracy criteria.

17. Key Words	18. Distribution Statement
LORAN-C Helicopter Navigation	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	38	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-CT-81-35	AD-A102520	

4. Title and Subtitle	5. Report Date
NATIONAL ICING FACILITIES REQUIREMENTS INVESTIGATION	June 1981
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s) F.R. Taylor and R.J. Adams	
9. Performing Organization Name and Address Systems Control, Inc. (Vt.) Champlain Technology Industries Division 2326 S. Congress Avenue, Suite 2-A West Palm Beach, Florida 33406	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFA01-80-C-10080
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	13. Type of Report and Period Covered Final Report 16 Dec 1980 - 1 May 1981 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

An analysis of National Icing Facilities requirements was performed at the request of the Federal Aviation Administration. This effort consisted of a five-month investigation to determine the scope and character of current and future icing facilities needs. This investigation included current aircraft needs as well as facilities that might be required for icing research, development and certification testing through the year 2000.

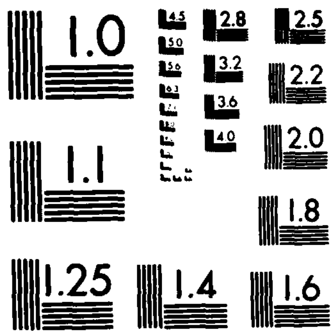
The information used for this study included all icing certification regulations for both fixed wing airplanes and rotorcraft. These regulatory requirements for icing certification were supplemented by a comprehensive analysis of current and future aircraft operational requirements. This independent facility requirements assessment was then compared to a previously published NASA review of icing facilities capabilities.

The conclusion was reached that the need for an inventory of National Icing Facilities currently exists and will become intensified in the next decade. The technical characteristics of these facilities were described and it was recommended that a joint FAA/NASA/DOD Task Force be established to formulate and spearhead the development of a National Icing Facilities Program.

17. Key Words	18. Distribution Statement
National Facilities Icing Tests Icing Certification Meteorological Conditions Icing Similitude	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	150	

AD-A174 697 FAA HELICOPTER/HELIPORT RESEARCH ENGINEERING AND 2/2
DEVELOPMENT BIBILIOGRAPHY 1964-1986(U) FEDERAL AVIATION
ADMINISTRATION WASHINGTON DC PROGRAM ENGINEE
UNCLASSIFIED R D SMITH NOV 86 DOT/FAA/PM-86/47 F/G 1/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-81/35	AD-A102521	

4. Title and Subtitle	5. Report Date
Development of a Heliport Classification Method and an Analysis of Heliport Real Estate and Airspace Requirements	June 1981
	6. Performing Organization Code: SSED/ESG
7. Author(s): F. D. Smith, A.G. DeLucien	8. Performing Organization Report No.: PAR-018-81
9. Performing Organization Name and Address: PACER Systems, Inc. 1755 Jefferson Davis Highway Suite 510 Arlington, VA 22202	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DOT-FA-01-80-C-10080
12. Sponsoring Agency Name and Address: U.S. Department of Transportation Federal Aviation Administration Systems Research & Development Service Washington, DC 20591	13. Type of Report and Period Covered: FINAL REPORT January to June 1981
	14. Sponsoring Agency Code: FAA/ARD-330

15. Supplementary Notes

16. Abstract

A helicopter performance related heliport classification method is developed which accomodates an applicable range of operating conditions and factors which impact helicopter performance. Dimensional values for use in planning both real estate and airspace surfaces are determined for application to the identified heliport classifications. Those values are incorporated into generalized guidelines for heliport planners to meet site-specific and non-standard operational conditions. Requirements for flight manual performance charts and published heliport information are also identified.

17. Key Words	18. Distribution Statement
Helicopter, Heliport, Real Estate, Airspace, Criteria, Performance, Obstacle, Surfaces, Guidelines.	This document is available to the U. S. public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	98	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-81/40	AD-A102209	

4. Title and Subtitle	5. Report Date
Improved Weather Services for Helicopter Operations in the Gulf of Mexico	June 1981
	6. Performing Organization Code
7. Author's: Arthur Hilsenrod *	8. Performing Organization Report No.
9. Performing Organization Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
	13. Type of Report and Period Covered: Final
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Systems Research and Development Service, Washington, D.C. 20591	14. Sponsoring Agency Code: FAA/ARD-400, ARD-300

15. Supplementary Notes

* The report contains information from a variety of sources. The acknowledgement page recognizes personnel that contributed to this report.

16. Abstract

Current weather services in support of the more than 800 helicopters operating in the Gulf of Mexico is reviewed and the limitations noted. Means of improving these services based on currently available facilities and ongoing research and development efforts are presented. Immediate improvements in weather services can be attained by the implementation of a plan agreed upon by personnel of the FAA, NWS and helicopter operators. Near-term (to 1986) and longer-term (beyond 1986) developments in observations, forecasts, and communications that can improve weather services are presented.

17. Key Words	18. Distribution Statement
Weather, helicopters, Gulf of Mexico forecasts, observations, communications	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	87	

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Technical Report Documentation Page

1. Report No. FAA-RD-81-55	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Recommended Changes to ATC Procedures for Helicopters		5. Report Date June 1981
		6. Performing Organization Code
7. Author(s) Glen A. Gilbert, T. K. Vickers, et al		8. Performing Organization Report No.
9. Performing Organization Name and Address Helicopter Association International (formerly Helicopter Association of America) 1110 Vermont Ave. N. W. Washington, D. C. 20005		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA79WA-4303/0003
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration 800 Independence Ave. S. W. Washington D. C. 20591		13. Type of Report and Period Covered Final Report October 1980- June 1981
		14. Sponsoring Agency Code ARD-330

15. Supplementary Notes

The study leading to this report was conducted as a result of an initiative by the FAA Helicopter Systems Branch of the Navigation and Landing Division under the direction of Raymond J. Hilton, Program Manager, and is particularly responsive to Recommendation No. 12 of Report No. FAA-RD-80-80.

16. Abstract

FAA Air Traffic Control Handbook 7110.65B was reviewed on a paragraph by paragraph basis to identify those changes considered necessary to more efficiently accommodate helicopters in the Air Traffic Control System. As a result of this review, specific proposed changes are set forth in this report. An HAA(HAI) special ATC study working group was established by the HAA program manager to assist in the conduct of the project, and various direct industry contacts were held to solicit inputs.

17. Key Words Helicopter Visual Flight Rules (VFR) Helicopter Special VFR (HSVFR) Fixed Wing Special VFR (FW/SVFR)	18. Distribution Statement Document is available to U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 179	22. Price

Technical Report Documentation Page

1. Report No. FAA-RD-81-59	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Helicopter Area Air Traffic Control Demonstration Plan		5. Report Date June 1981
		6. Performing Organization Code
7. Author(s) T. K. Vickers, D. J. Freund		8. Performing Organization Report No.
9. Performing Organization Name and Address Federal Aviation Administration Systems Research & Development Service Helicopter Systems Branch Washington, D.C. 20590		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Program Plan
		14. Sponsoring Agency Code ARD-330

15. Supplementary Notes
This effort was sponsored by the Systems Research and Development Service, Navigation and Landing Division, Helicopter Systems Branch, under the direction of Raymond J. Hilton, Program Manager

16. Abstract

As part of the Helicopter Operations Development Plan, this document outlines a phased study of area navigation applications in the control of low-altitude IFR helicopter operations, with particular emphasis on methods of reducing controller workload in order to make the use of direct random routes feasible. Each of the four phases of the plan embodies analysis, simulation, and validation. The study is evolutionary; Phase 1 starts with the basic functions of generating conflict-free routes, and maintaining positive separation between aircraft in areas outside of radar coverage. Phase 2 introduces terrain problems in mountainous areas. Phase 3 investigates interactions between fixed and random routes, and between fixed-wing aircraft and helicopters in major terminal areas. Phase 4 provides further complications in the study of off-optimum operations (interruptions in navigation, communications, and surveillance coverage) in which the airborne separation assurance function will be investigated. A broad outline of the entire plan is presented, with a detailed schedule of the first phase.

17. Key Words Air Traffic Control, Helicopter, IFR, Random Routes, RNAV, Simulation, Separation Assurance		18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161	
19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages 24	22. Price

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Technical Report Documentation Page

1. Report No. FAA-RD-81-92	2. Government Accession No. AD-A108877	3. Recipient's Catalog No.
4. Title and Subtitle WEATHER DETERIORATION MODELS APPLIED TO ALTERNATE AIRPORT CRITERIA		5. Report Date September 1981
		6. Performing Organization Code
7. Author(s) EDWIN D. McCONKEY		8. Performing Organization Report No.
9. Performing Organization Name and Address SYSTEMS CONTROL TECHNOLOGY, INC. 2326 S. CONGRESS AVE., SUITE 2A WEST PALM BEACH, FL 33406		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA79NA-6029
12. Sponsoring Agency Name and Address DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION SYSTEMS RESEARCH AND DEVELOPMENT SERVICE WASHINGTON, DC 20590		13. Type of Report and Period Covered INTERIM REPORT
		14. Sponsoring Agency Code FAA-ARD 330
15. Supplementary Notes		

16. Abstract

Flights under Instrument Flight Rules (IFR) require the filing of a flight plan. The flight plan must contain an alternate airport unless certain conditions at the destination are met. These conditions concern the availability of an instrument approach procedure and anticipated meteorological conditions within one hour of the estimated arrival time. Certain other conditions must be met for an airport to qualify as an alternate airport. These conditions also are based on instrument approach procedure availability and forecast meteorological conditions. Relaxation of the current requirements regarding alternate airports could benefit some aircraft operators by improving schedule reliability and reducing the number of weather related departure delays.

The investigation quantified the increased risk of ceilings and visibilities being below landing minimums at several cities in the conterminus U.S. if requirements are relaxed. The study methods utilized climatology data and weather deterioration models to calculate the probability of an airport being below precision and non-precision approach minimums.

The preliminary findings indicate that relaxing the current alternate airport criteria would increase the risk that an airport would be below landing minimums. It was also shown that this increase in risk could be offset by limiting the relaxation of the regulations to those flights which are of short duration (less than two hours). Possible changes to the current Federal Aviation Regulations regarding alternate airports are presented.

17. Key Words WEATHER MODELS FEDERAL AVIATION REGULATIONS ALTERNATE AIRPORTS CLIMATOLOGY	18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED		104	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-CT-81-167		

4. Title and Subtitle	5. Report Date
Terminal Helicopter Instrument Procedures (TERPS)	April 1981
	6. Performing Organization Code
	8. Performing Organization Report No. FAA-CT-81-167
7. Author(s) Robert H. Pursel	
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08504	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Aviation Administration Office of Flight Operations Washington, D.C, 20591	13. Type of Report and Period Covered Test Plan
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Federal Aviation Administration (FAA) Technical Center Helicopter Project is designed to provide actual flight test data to the FAA Office of Flight Operations (AFO) to aid in the updating and streamlining of helicopter terminal area procedures and criteria. The data gathered here will be used toward the revision of chapter 11 of the *Terminal Instrument Procedures* (TERPS) Manual which deals with "helicopter only" terminal operations. This project will deal primarily with the approach and missed approach phases of helicopter terminal operations. The project will explore and provide data on precision and non-precision instrument landing system (ILS) and omnidirectional radio range (VOR) approaches. The project will document the actual operating characteristics of representative Instrument Flight Rules (IFR) certificated helicopter types now in civil and military use.

To aid in the determination of total system error in the terminal/approach phase subject helicopter pilots of varying backgrounds and experience levels will be utilized.

17. Key Words	18. Distribution Statement
Terminal Instrument Procedures (TERPS) Precision Approach Helicopter Missed Approach Instrument Flight Rules	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	24	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-CT-81-180 FAA-ED-18-8		

4. Title and Subtitle

ENGINEERING AND DEVELOPMENT PROGRAM PLAN — HELICOPTER ICING TECHNOLOGY RESEARCH

5. Report Date

June 1981

6. Performing Organization Code

7. Author(s)

Flight Safety Branch, ACT-340

8. Performing Organization Report No.

FAA-CT-81-180

9. Performing Organization Name and Address

Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

182-340-000

12. Sponsoring Agency Name and Address

U.S. Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20590

13. Type of Report and Period Covered

Program Plan

14. Sponsoring Agency Code

15. Supplementary Notes

This program plan forms the basis of the section on helicopter icing in the agency Helicopter Operations and Airworthiness Research and Development Plan (Report Number FAA-RD-78-101, dated September 1978).

16. Abstract

The Federal Aviation Administration (FAA) program discussed in this plan is established to provide an identification of the helicopter icing problem as it is currently known, the methodology, and the resource requirements for conduct of the efforts necessary for resolution of known problem areas. This program plan defines four specific subprograms: (1) Icing Atmospheric Research for helicopters (which may be applicable to other low-altitude, slow-flying, fixed-wing aircraft); (2) Test and Operational Technology necessary to enhance safety during helicopter icing testing and ice protection operations system technology for application to helicopters; (3) the technology such as simulation testing and analytical techniques for development and testing of helicopters for flight in icing conditions; and (4) the development of technology for use by the FAA in its regulatory and advisory documentation efforts to assure safe, timely, and cost effective certification of helicopter ice protection.

Results of efforts under this program are intended to be directed primarily to regulatory authorities of the FAA for implementation as appropriate and necessary.

17. Key Words	18. Distribution Statement
Helicopter Icing Ice Protection Icing Test Facilities Simulation	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	34	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-82/6	AD-A120678	
4. Title and Subtitle INSTRUMENT APPROACH AIDS FOR HELICOPTERS		5. Report Date July 1982
		6. Performing Organization Code
7. Author(s) Edwin D. McConkey and Ronald E. Ace		8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control Technology, Inc. 2326 S. Congress Ave., Suite 2A West Palm Beach, FL 33406		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFA-1-80-C-10080
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Final Report January 1981-January 1982
		14. Sponsoring Agency Code ARD-330
15. Supplementary Notes		

16. Abstract

This report identifies the various instrument approach procedures that are available to the helicopter operator. Emphasis is placed on the recently approved "Helicopter Only" procedures, the criteria for which are contained in Chapter 11 of the Terminal Instrument Procedures Handbook.

The objective of this study was to examine currently available solutions to helicopter approach needs. The study also covers new and innovative solutions to helicopter approach requirements. This was accomplished by:

- Identifying the various navigation aids now being used which may have general application to U.S. helicopter operations.
- Describing typical locations of use, typical approach procedures, and minimums for each of these aids.
- Providing estimated equipment costs for both the ground and airborne portions of these systems.
- Discussing the rationale used to support the use of a particular aid at a particular location or in a specific operational environment.

Results of this investigation are presented in the form of a series of helicopter instrument approach options for the user.

17. Key Words	18. Distribution Statement
INSTRUMENT APPROACH PROCEDURES NAVIGATION HELICOPTERS	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	93	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-82/7	AD-A121169	

4. Title and Subtitle	
FLIGHT TEST INVESTIGATION OF AREA CALIBRATED LORAN-C FOR EN ROUTE NAVIGATION IN THE GULF OF MEXICO	5. Report Date September 1982
	6. Performing Organization Code ACT-100
7. Author(s) John G. Morrow	8. Performing Organization Report No. DOT/FAA/CT-81/72
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. 045-390-130
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	13. Type of Report and Period Covered Final Report July 8-9, 1980
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Flight tests of two Loran-C airborne navigators were conducted in the Gulf of Mexico oil/gas exploration and production area. Two systems were installed in a Federal Aviation Administration (FAA) CV-580 aircraft to examine simultaneously the performance of a Loran-C receiver operated in an area-calibrated mode and one operated in an uncalibrated model. Two separate test routes were flown over a period of 2 days. These routes covered the central and western test areas of the Gulf of Mexico and an overland route from Palacios, Texas, to Lafayette, Louisiana. An Inertial Navigation System (INS) was used as a position reference standard. The INS data were updated to correct for drift. Accuracy of the position reference from the corrected INS data was ±0.3 nautical mile.

The flight tests indicated that the use of area calibration greatly increased the area of compliance with Advisory Circular 90-45A en route accuracy requirements in the flight test.

This report is a followup of report No. FAA-RD-80-47 (FAA-CT-80-18), "Flight Test Investigation of Loran-C for En Route Navigation in the Gulf of Mexico."

17. Key Words	18. Distribution Statement
Loran-C En Route Navigation Area Navigation RNAV	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	50	

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Technical Report Documentation Page

1. Report No. DOT/FAA/RD-82/8	2. Government Accession No. AD-A119289	3. Recipient's Catalog No.
4. Title and Subtitle INITIAL FAA TESTS ON THE NAVIGATION SYSTEM USING TIME AND RANGING GLOBAL POSITIONING SYSTEM Z-SET		5. Report Date July 1982
		6. Performing Organization Code ACT-100
7. Author(s) Robert J. Esposito		8. Performing Organization Report No. DOT/FAA/CT-81/73
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 049-330-110
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Interim Report April through December 1980
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The Federal Aviation Administration (FAA) received a Navigation System Using Time and Ranging (NAVSTAR) Global Positioning System (GPS) Z-set for independent test and evaluation after this receiver was acceptance tested aboard a United States Air Force C-141 aircraft over the Yuma Proving Ground instrumented range. This report describes the initial familiarization studies conducted by the FAA in a twin turboprop engine Grumman Gulfstream with the Z-set in a stand-alone configuration. The familiarization studies included satellite shielding tests, satellite acquisition/reacquisition tests, nonprecision approaches to five east coast airports, and operations in high noise/radiofrequency interference (RFI) environments (over airports, cities, and television towers).

17. Key Words	18. Distribution Statement
NAVSTAR-GPS Z-Set Receiver Global Positioning System RFI Tests	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	15	

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-82/9	AD-A119306	

4. Title and Subtitle	
FAA ACCEPTANCE TESTS ON THE NAVIGATION SYSTEM USING TIME AND RANGING GLOBAL POSITIONING SYSTEM Z-SET RECEIVER	5. Report Date: July 1982
	6. Performing Organization Code: ACT-100
7. Author(s): Robert J. Esposito	8. Performing Organization Report No.: DOT/FAA/CT-81/75
9. Performing Organization Name and Address: Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: 049-330-110
	13. Type of Report and Period Covered: Final Report June 1979 - December 1979
12. Sponsoring Agency Name and Address: U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report describes Federal Aviation Administration (FAA) acceptance tests on the Navigation System Using Time and Ranging (NAVSTAR) Global Positioning System (GPS) Z-set receiver which were conducted in a United States Air Force (USAF) System Command C-141 aircraft over the instrumented range located at the Yuma Proving Ground. The Yuma laser tracking system computed a reference trajectory against which the GPS receiver solution was compared. Data from five flights, totaling over 6 hours, are presented with the objective of assessing Z-set capabilities to meet civil aviation requirements for nonprecision approaches.

17. Key Words	18. Distribution Statement
Global Positioning System NAVSTAR/GPS Z-Set Receiver	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	20	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-82/16	AD-A120106	

4. Title and Subtitle
3D Loran-C Navigator Documentation

5. Report Date
January 1982

6. Performing Organization Code

8. Performing Organization Report No.

7. Author(s)
Eric H. Bolz, Larry D. King

9. Performing Organization Name and Address
Systems Control Technology, Inc.
2326 S. Congress Ave., Suite 2A
West Palm Beach, Florida 33406

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DTFA01-80-C-10080

12. Sponsoring Agency Name and Address
Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Final Report
May 1981 - January 1982

14. Sponsoring Agency Code
ARD-320

15. Supplementary Notes

16. Abstract

The purpose of this task was to develop a 3D Loran-C Navigator by configuring an interface unit between an airborne Loran-C navigator (Teledyne TDL-711) and an Altitude Alerter/VNAV Guidance system (Intercontinental Dynamics model 541). The digital computer-based interface unit was designed to allow the flight crew to specify the approach slope (3.0 to 9.9 degrees). This report documents the hardware and software in the interface unit, and interconnection with the other involved systems.

The availability of accurate, three-dimensional approach guidance information at airports where no ILS is available provides significant operational advantages, to helicopter operators in particular. The 3D Loran-C navigator system was bench tested and flight demonstrated. Smooth, accurate (within the limitations of Loran-C) descent guidance information was obtained.

17. Key Words
INSTRUMENT APPROACH, LORAN-C, PRECISION APPROACH, 3D NAVIGATION, VNAV, MICROCOMPUTER APPLICATIONS

18. Distribution Statement
This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	60	

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Technical Report Documentation Page

1. Report No. DOT/FAA/RD-82/24	2. Government Accession No. AD-A123465	3. Recipient's Catalog No.
4. Title and Subtitle LORAN-C EN ROUTE ACCURACIES IN THE CENTRAL APPALACHIA REGION		5. Report Date November 1982
		6. Performing Organization Code ACT-100
7. Author(s) Frank Lorge		8. Performing Organization Report No. DOT/FAA/CT-82/32
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 045-390-130
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Final Report April 1980
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Flight tests were conducted in the central Appalachian Region of the United States to measure en route Loran-C position accuracies at low altitudes in mountainous terrain. Receivers were configured to use the Northeast and Great Lakes Chains of Loran-C transmitters during the flights while position information and receiver status were recorded. Comparisons were made between each of the recorded Loran positions and position information derived from the Inertial Navigation System. The results were compared against Advisory Circular (AC) 90-45A accuracy criteria for the en route phase of flight. It is concluded that both the Northeast United States Chain and the Great Lakes Chain meet AC 90-45A en route accuracy criteria over the entire flight test area.

17. Key Words Loran-C, Navigation, Radio Navigation, Low Altitude Navigation	18. Distribution Statement This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 29	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-82/40	PB84-116458	

4. Title and Subtitle	5. Report Date
APPLICATION OF THE MICROWAVE LANDING SYSTEM TO HELICOPTER OPERATIONS	September 1982
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
E.D. McConkey, J.B. McKinley and R.E. Ace	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Systems Control Technology, Inc. 2326 South Congress Avenue, Suite 2A West Palm Beach, Florida 33406	11. Contract or Grant No. DTFA-1-80-C-10080
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Final Report
Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	14. Sponsoring Agency Code ARD-330

15. Supplementary Notes

16. Abstract

This report identifies ways in which the Microwave Landing System (MLS) can be utilized to aid helicopter operations. Consideration is given to the following study areas:

- helicopter instrument approach requirements by type of operation
- helicopter instrument approach requirements by operational area
- types of potential approach procedures that could be used by helicopters
- helicopter performance considerations during approach, landing and missed approach procedures
- ground and airborne MLS equipment
- benefits and costs associated with the use of MLS in helicopter operations

The operational areas considered in the study are: city centers, major hub airports, non-hub airports, remote areas, and offshore oil rig support. MLS procedures can be applied to each of these operational areas. From an economic standpoint, operations at city center heliports, major hub airports, non-hub airports, and remote areas will have benefits that exceed costs if operations counts are sufficiently large. Offshore operations will not have benefits that exceed costs due to the availability of alternative approach procedures.

17. Key Words	18. Distribution Statement
Helicopters Microwave Landing System Instrument Approach Procedures Navigation	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	124	

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-82/57	2. Government Accession No. AD-A117445	3. Recipient's Catalog No.

4. Title and Subtitle

NORTHEAST CORRIDOR HELICOPTER AREA NAVIGATION ACCURACY EVALUATION

5. Report Date June 1982

6. Performing Organization Code

7. Author's)

Jack D. Edmonds

8. Performing Organization Report No. DOT/FAA/CT-82/57

9. Performing Organization Name and Address

Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No. 045-330-130

12. Sponsoring Agency Name and Address

Federal Aviation Administration
Technical Center
Atlantic City, Airport, New Jersey 08405

13. Type of Report and Period Covered

Data Report
July 1979 - April 1980

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report presents area reduced navigation accuracy test flight data collected along an experimental area naviation route structure — the so-called Northeast Corridor. This corridor is an experimental helicopter airway structure extending between Washington, D.C., and Boston, Mass. It consists of 2 one-way, reduced width (4 nautical miles (nmi)) airways including one route spur from Allentown, Pa. These flight tests were a joint effort of the Federal Aviation Administration and the Helicopter Association International (HAI). The objective was to determine if the NEC could be navigated within the 4-nmi airway boundary at the 95 percent confidence level required by Advisory Circular (AC) 90-45A, "Approval of Area Navigation Systems for Use in the U.S. National Airspace System."

17. Key Words

Northeast Corridor
Area Navigation
Total System Crosstrack Error
Helicopter Navigation

18. Distribution Statement

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	34	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-82/63	AD-A119578	

4. Title and Subtitle	5. Report Date
EMC ANALYSIS OF A PROTOTYPE CIVIL-USE GPS RECEIVER ON FOUR AIRCRAFT CONFIGURATIONS	July 1982
	6. Performing Organization Code
7. Author(s) Robert L. Mullen	8. Performing Organization Report No. ECAC-CR-82-048
9. Performing Organization Name and Address Department of Defense Electromagnetic Compatibility Analysis Center Annapolis, Maryland 21402	10. Work Unit No. (TRAIS) 11. Contract or Grant No. CDRL # 10P F-10628-80-C-0042
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591	13. Type of Report and Period Covered Consulting Report 14. Sponsoring Agency Code ARD-300

15. Supplementary Notes

16. Abstract

The cosite electromagnetic compatibility aspects were evaluated for the simultaneous operation of a prototype civil-use GPS receiver and other avionic systems on board four specific aircraft configurations.

17. Key Words	18. Distribution Statement
Electromagnetic Compatibility GPS Boeing 747 Boeing 727 Rockwell Aerocommander	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	71	

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Technical Report Documentation Page

1. Report No. DOT/FAA/RD-82/71	2. Government Accession No. AD-A125459	3. Recipient's Catalog No.
4. Title and Subtitle GLOBAL POSITIONING SYSTEM EN ROUTE/TERMINAL EXPLORATORY TESTS		5. Report Date December 1982
		6. Performing Organization Code ACT-100
7. Author(s) Jerome T. Connor, Robert J. Esposito, and Philip Lizzi		8. Performing Organization Report No. DOT/FAA/CT-82/64
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 049-311-110
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590		13. Type of Report and Period Covered Final Report March 1981 - February 1982
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Federal Aviation Administration Technical Center performed this effort under the Technical Program Document 04-109, subprogram 049-311, project Navigation Satellite Timing and Ranging (NAVSTAR)/Global Positioning System (GPS). The report covers the exploratory laboratory test in 1981 and 33-hour flight test from June through July 1981 of the single channel GPS receiver (Z-set) manufactured by Magnavox and procured by the Department of Defense (DOD). The report documents the performance of the Z-set in the laboratory and during different flight profiles including rectangles, orbits, radials, nonprecision approaches, and area en route flights to the Philadelphia, Dulles, Norfolk, Wilmington, and John F. Kennedy Airports during periods when up to five satellites were visible to the antenna.

17. Key Words	18. Distribution Statement
NAVSTAR Global Positioning System (GPS) Z-Set	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	121	

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Technical Report Documentation Page

Field	Value
1. Report No.	DOT/FAA/RD-82/78
2. Government Accession No.	AD-A131034
3. Recipient's Catalog No.	
4. Title and Subtitle	LORAN-C NONPRECISION APPROACHES IN THE NORTHEAST CORRIDOR
5. Report Date	June 1983
6. Performing Organization Code	ACT-100
7. Author(s)	Frank Lorge
8. Performing Organization Report No.	DOT/FAA/CT-82/76
9. Performing Organization Name and Address	Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405
10. Work Unit No. (TRAIS)	
11. Contract or Grant No.	045-330-130
12. Sponsoring Agency Name and Address	U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590
13. Type of Report and Period Covered	Final Report Sept. 1981 - Jan. 1982
14. Sponsoring Agency Code	
15. Supplementary Notes	

16. Abstract

This report describes a flight test designed to investigate the suitability of Loran-C as a nonprecision approach aid in the Northeast Corridor (NEC). Approaches were flown at six selected airports in the NEC by a CH-53A helicopter using Loran-C for course guidance. Accuracy criteria specified in Advisory Circular (AC) 90-45A were used as the standard for acceptability. Data were recorded for Loran in area calibrated and uncalibrated modes along with very high frequency omnidirectional radio range (VOR)/distance measuring equipment (DME) raw sensor data for comparison. The results show that the group repetition interval (GRI)-9960 Northeast U.S. Loran-C chain met AC 90-45A requirements for nonprecision approaches in all cases when a local area calibration was applied. The uncalibrated mode met AC 90-45A requirements at four of the six airports. It was determined that the Seneca, Nantucket, Carolina Beach triad should be used for navigation throughout the flight test area.

17. Key Words	18. Distribution Statement
Loran-C Nonprecision Approach Northeast Corridor Area Navigation (RNAV) Helicopter Navigation	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	74	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-82/103		

4. Title and Subtitle	
FLIGHT TEST ROUTE STRUCTURE STATISTICS OF HELICOPTER GPS NAVIGATION WITH THE MAGNAVOX Z-SET	5. Report Date December 1982
	6. Performing Organization Code ACT-100
7. Author(s) Robert D. Till	8. Performing Organization Report No. DOT/FAA/CT-82/103
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. 045-330-130
12. Sponsoring Agency Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	13. Type of Report and Period Covered Data Report July 1981 - November 1981
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Federal Aviation Administration (FAA) Technical Center conducted this test project under Technical Program Document (TPD) 04-150 to determine the operational suitability of the Navigation Satellite Timing and Ranging Global Positioning System (NAVSTAR GPS) for rotary wing aircraft. The flight tests were conducted in a CH-53A helicopter using a prototype low cost GPS receiver, the Magnavox Z-set. Over 15 hours of radar tracked en route and nonprecision approach flight tests were flown with two-dimensional GPS derived guidance (crosstrack and distance-to-go) used as the primary navigation system.

This report includes tabulated statistical analysis of navigation errors for the flight test route segments flown. The results of the data presented in this report are summarized, analyzed, and discussed in the FAA Technical Center final report number FAA/CT-82/74, "Helicopter GPS Navigation with the Magnavox Z-Set."

17. Key Words	18. Distribution Statement
NAVSTAR GPS Z-Set Helicopter	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	41	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-82/120		

4. Title and Subtitle
All Weather Heliport

5. Report Date
October 1982

6. Performing Organization Code

7. Author(s)
Paul H. Jones

8. Performing Organization Report No.
DOT/FAA/CT-82/120

9. Performing Organization Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

13. Type of Report and Period Covered
Project Plan

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

With the increasing number of IFR certificated helicopters and improvements in electronic approach guidance systems, many helicopters will soon be capable of executing IFR approaches to heliports. In order to support these operations, an IFR lighting and marking system is required.

This project plan describes an effort to develop and evaluate Visual Guidance Systems to support heliport operations during Instrument Meteorological Conditions (IMC). Project to include the following:

a. Survey of Instrument Flight Rules (IFR) heliport visual aids presently in use and review of previous flight test reports.

b. Development of new and modified visual guidance aids/systems.

c. Flight testing of the proposed system at an operational heliport.

A formal report detailing results of the developmental testing and evaluation, and giving recommendations for components and configuration of a standard IFR heliport lighting and marking system will be issued.

17. Key Words
Heliport Lighting
Visual Guidance Systems

18. Distribution Statement
Document is on file at the Technical Center Library, Atlantic City Airport, New Jwesey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	7	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN83/03		

4. Title and Subtitle

HELICOPTER GLOBAL POSITIONING SYSTEM NAVIGATION WITH THE MAGNAVOX Z-SET

5. Report Date
August 1983

6. Performing Organization Code
ACT-100

7. Author(s)
Robert D. Till

8. Performing Organization Report No.
DOT/FAA/CT-TN83/03

9. Performing Organization Name and Address
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
045-330-130

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Program Engineering and Maintenance Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Technical Note
July 1981 - January 1982

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Federal Aviation Administration Technical Center conducted this test project under Technical Program Document (TPD) 04-150 to determine the operational suitability of the Navigation Satellite Timing and Ranging Global Positioning System (NAVSTAR GPS) for rotary wing aircraft. The flight tests were conducted in a CH-53A helicopter using a prototype low-cost GPS receiver, the Magnavox Z-set, over a period of performance from July 1981 to January 1982. Over 15 hours of radar tracked en route and nonprecision approach flight tests were flown with two-dimensional GPS derived guidance (crosstrack and range to go) used as the primary navigation system.

This report includes laboratory and flight test results that demonstrate perturbational effects from the following conditions: multipath, satellite shielding, user-satellite geometry, vehicle dynamics, weather, and navigation satellite constellation change. The flight test data were analyzed in this report for compliance with the requirements of Advisory Circular (AC) 90-45A and the technical and operational issues specified in the Federal Radionavigation Plan (FRP).

17. Key Words
NAVSTAR
GPS
Z-Set
GDOP
Helicopter GPS

18. Distribution Statement
Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	158	

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-83/4	AD-A123083	

4. Title and Subtitle	5. Report Date
ALASKA LORAN-C FLIGHT TEST EVALUATION	March 1983
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s) L.D. KING AND E.D. McCONKEY	
9. Performing Organization Name and Address Systems Control Technology, Inc. 2326 S. Congress Avenue, Suite 2A West Palm Beach, Florida 33406	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-FA01-80-C-10080
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20590	13. Type of Report and Period Covered Final Report
	14. Sponsoring Agency Code FAA APM-420

15. Supplementary Notes

16. Abstract

This report contains the description and results of a Loran-C flight test program conducted in the State of Alaska. The testing period was from August 1982 to September 1982. The purpose of the flight test was to identify applicable Loran-C accuracy data for the Alaskan air taxi and light aircraft operators so that a Supplemental Type Certificate (STC) can be issued in the Alaska Region for the Loran-C system tested (Teledyne TDL-711).

Navigation system errors were quantified for the Loran-C unit tested. The errors were computed from knowledge of position calculated from ground truth data and the indicated position of the navigator. Signal coverage, bias and flight technical error data were also obtained. Multilateration ground truth, photographic ground truth, and data acquisition systems were carried aboard the test aircraft.

The tests were concentrated in the southwest part of the Alaskan mainland. An interconnecting network of routes west of Anchorage and south of a line from Fairbanks to Kotzebue were flown for data collection. Of particular interest was the area around, and to the west of, Bethel where there are currently very few aids to air navigation.

The North Pacific Loran-C chain with stations at St. Paul Island (Master), Port Clarence (Yankee) and Narrow Cape (Zulu) was used in this area. Test results indicate that Loran-C has sufficient signal coverage and accuracy to support aircraft enroute navigation in much of the test area. In the area around Anchorage the test unit failed to consistently acquire and track the signal, however. Further analysis of the data and testing are required in the Anchorage area.

17. Key Words	18. Distribution Statement
NAVIGATION LORAN-C FLIGHT TEST	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	103	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-83/6	AD-A130074	

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code / 8. Performing Organization Report No.
GENERAL AVIATION SAFETY RESEARCH ISSUES	5. June 1983
7. Author(s): Robert J. Ontiveros	8. DOT/FAA/CT-83/6
9. Performing Organization Name and Address: Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS) / 11. Contract or Grant No. 184-341-500
12. Sponsoring Agency Name and Address: U.S. Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20590	13. Type of Report and Period Covered: Final / 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report is a compilation of general aviation safety research issues extracted and summarized from recent studies conducted by the Federal Aviation Administration (FAA), other government agencies, and the aviation industry. It offers an overview of conclusions and recommendations that highlight current and future problem areas in general aviation. The report addresses the expressed needs as defined by these studies which counsel research and development relevant to the interrelationships of man, machine, and environment to effectively improve the general aviation safety record.

17. Key Words	18. Distribution Statement
Airman Training, Aircraft Safety, General Aviation Safety, Weather Safety	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	35	

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-83/7	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ENGINEERING AND DEVELOPMENT PROGRAM PLAN — AIRCRAFT ICING		5. Report Date August 1983
		6. Performing Organization Code ACT-340
7. Author(s) Flight Safety Research Branch, ACT-340		8. Performing Organization Report No.
9. Performing Organization Name and Address Federal Aviation Administration Flight Safety Research Branch, ACT-340 Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 182-340-200
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Washington, D.C. 20591		13. Type of Report and Period Covered Program Plan
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A Federal Aviation Administration (FAA) research program is presented to identify the aircraft icing problem and discuss the methodology and resource requirements planned to resolve them. This program plan is divided into three subprogram areas: (1) Atmospheric Criteria — The development of meteorological icing certification criteria to permit safe flight operations for all types of aircraft in all types of icing conditions; (2) Procedures and Technology — The development of technical data necessary to enhance certification and operational use of advanced ice protection concepts; (3) Simulation Techniques — The use of computer and facility icing simulation technology to enhance the certification process. All program efforts described fall into the area of regulatory development and technical support.

Heavy reliance is placed on cooperative efforts with other government agencies with expertise and icing facilities.

17. Key Words Aircraft Icing, Helicopter Icing, Ice Protection, Icing Test Facilities, Simulation, Meteorological Icing Criteria	18. Distribution Statement

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	20	

Technical Report Documentation Page

1. Report No. DOT/FAA/CT-83/21 (NRL Report 8738)	2. Government Accession No. AD-A137589	3. Recipient's Catalog No.

4. Title and Subtitle
A NEW DATA BASE OF SUPERCOOLED CLOUD VARIABLES FOR ALTITUDES UP TO 10,000 FT AGL AND THE IMPLICATIONS FOR LOW ALTITUDE AIRCRAFT ICING

5. Report Date
August 1983

6. Performing Organization Code

7. Author(s)
Richard K. Jeck

8. Performing Organization Report No.

9. Performing Organization Name and Address
Naval Research Laboratory
4555 Overlook Avenue, SW
Washington, DC 20375

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
182-340-200

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration Technical Center
Atlantic City Airport, NJ 08405

13. Type of Report and Period Covered
Final Report
January 1979 to June [illegible]

14. Sponsoring Agency Code
FAA/ACT-340

15. Supplementary Notes

FAA Contract FA79[illegible]-020

16. Abstract

[illegible] miles (nmi) of airborne measurements in a variety of supercooled cloud types and weather conditions up to 10,000 feet (3 kilometers) above ground level (AGL) have been computerized to form a new Data Base of cloud variables applicable to low altitude aircraft icing studies. Half of the data is from the aircraft icing research flights conducted by the National Advisory Committee for Aeronautics (NACA) in 1946-50. The other half is from recent wintertime research flights by the Naval Research Laboratory and other organizations, mostly over the conterminous United States (CONUS) and nearby offshore areas. The Data Base includes liquid water content (LWC), cloud droplet median volume diameter (MVD), true outside air temperature (OAT), horizontal extent and altitude of uniform cloud intervals as well as information on cloud type, weather conditions, date and geographic location, and other data.

A variety of analyses are illustrated which yield these principal conclusions: The NACA and modern CONUS measurements generally agree in most aspects for similar amounts of data in similar cloud and weather conditions. The Intermittent Maximum and Continuous Maximum "envelopes" in the Federal Aviation Regulations, Part 25 (FAR-25), Appendix C, do not correctly describe the icing environment for altitudes up to 10,000 feet AGL. The average ice accretion rate appears to be independent of altitude between 2000 and 10,000 feet AGL.

17. Key Words
Aircraft Icing
Helicopter Icing
Aircraft Certification
Icing [illegible]
[illegible]
Liquid Water Content
Icing Conditions

18. Distribution Statement
Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	[illegible]	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-83/22	AD-A130946	

4. Title and Subtitle	5. Report Date
A NEW CHARACTERIZATION OF SUPERCOOLED CLOUDS BELOW 10,000 FEET AGL	June 1983
	6. Performing Organization Code
	8. Performing Organization Report No. DOT/FAA/CT-83/22
7. Author(s) Charles O. Masters	
9. Performing Organization Name and Address FAA Technical Center Aircraft and Airport Systems Technology Div., ACT-300 Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. 182-340-200
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Icing envelopes which effectively characterize supercooled clouds from ground level to 10,000 feet above ground level over the conterminous United States have been generated from a new data base of aerial observations. This data base, recently established via an Interagency Agreement between the FAA and the Naval Research Laboratory is the largest, most significant compilation of low-altitude supercooled characteristics currently in existence. It is intended that this new characterization serve as a basis for the establishment of design criteria and regulations that pertain to ice protection systems and equipments for low performance aircraft which typically operate below 10,000 feet. This new characterization groups the supercooled cloud properties for all cloud types observed into three temperature ranges and presents their associated values of liquid water content (LWC), range of median volume droplet diameters (MVD), and icing event duration. Details of the analysis process are discussed which use a least squares logarithmic regression estimation technique to predict the extreme values of supercooled cloud properties.

17. Key Words	18. Distribution Statement
Aircraft Icing Helicopter Icing Supercooled Clouds Liquid Water Content	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	47	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-83/32	AD-A140264	December 1983

4. Title and Subtitle	5. Report Date
CONUS Loran-C Error Budget	
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s) L.D. King, K.J. Venezia and E.D. McConkey	
9. Performing Organization Name and Address	**10. Work Unit No. (TRAIS)** DTFA01-83-C-20041
Systems Control Technology, Inc. 2326 S. Congress Ave., Suite 2A West Palm Beach, Florida 33406	**11. Contract or Grant No.**
12. Sponsoring Agency Name and Address	**13. Type of Report and Period Covered**
Department of Transportation Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591	FINAL REPORT
	14. Sponsoring Agency Code FAA APM-420

15. Supplementary Notes

16. Abstract

This report contains the description and results of a Loran-C flight test program conducted in the continental United States (CONUS). The data collection period was during July 1983. The purpose of the program was to collect Loran-C signal coverage and accuracy data representative of low altitude, low speed operations typical of helicopters and general aviation aircraft.

The test aircraft used was a Beechcraft Queen Air, Model 65. The aircraft was configured with a data collection palate and multipin electrical connectors located in the aircraft cabin. A Teledyne TDL-711 navigation receiver was used in the test, utilizing an E-field antenna mounted on the top of the fuselage. A microprocessor controlled data collection system, utilizing a scanning DME and other aircraft navigation instruments, was used to record data and establish aircraft reference position.

Route segments, totaling over 9500 nm covering much of CONUS, were flown during the project. Data were recorded on all route segments. Over 12,000 data points were used in the accuracy analysis. Calibration procedures, used at five locations, reduced errors throughout an area within a 75 nm radius of the calibration point.

17. Key Words	18. Distribution Statement
Navigation Flight Test Loran-C	Document is available to the U.S. Public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	118	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-83/40	AD-A134125	

4. Title and Subtitle

SURVEY OF CHARACTERISTICS OF NEAR MID-AIR COLLISIONS INVOLVING HELICOPTERS

5. Report Date

August 1983

6. Performing Organization Code

7. Author(s)

Barry R. Billmann

8. Performing Organization Report No.

DOT/FAA/CT-83/40

9. Performing Organization Name and Address

Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

052-244-340

12. Sponsoring Agency Name and Address

U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

13. Type of Report and Period Covered

Final Report

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Rotorcraft operating characteristics may require a collision avoidance system to perform a substantially different function than is provided to conventional fixed wing aircraft by Traffic Alert and Collision Avoidance System (TCAS) I or the Minimum TCAS II. This paper has been prepared to provide analysis of environmental conditions and operational characteristics of near mid-air collision situations involving rotorcraft. The analysis is intended to provide data in establishing preliminary human factors and procedural design requirements for a rotorcraft collision avoidance system. The information should be used to establish TCAS Rotorcraft Program experimental requirements.

17. Key Words

Fixed Wing Aircraft
Helicopter
Mid-Air Collision
Rotorcraft
TCAS

18. Distribution Statement

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	25	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN83/50		

4. Title and Subtitle	5. Report Date
GLOBAL POSITIONING SYSTEM (GPS) PERFORMANCE PARAMETERS TEST PLAN	June 1984
	6. Performing Organization Code: ACT-140
7. Author(s): Jerome T. Connor	8. Performing Organization Report No.: DOT/FAA/CT-TN83/50
9. Performing Organization Name and Address: Federal Aviation Administration Technical Center Atlantic City Airport, N.J. 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: T07-04A
12. Sponsoring Agency Name and Address: U.S. Department of Transportation Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered: Technical Note September 1983 to September 1986
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This test plan describes a series of tests that will be conducted over the next several years to evaluate Global Positioning System (GPS) receivers in different phases of navigation, different physical situations, and environmental conditions. The test plan will consist of a number of detailed test descriptions that will be incorporated into the plan as the GPS test program continues and the need arises.

17. Key Words	18. Distribution Statement
NAVSTAR GPS Z-SET	Document is on file at the Technical Center Library, Atlantic City Airport, N.J. 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	24	

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Technical Report Documentation Page

1. Report No.: DOT/FAA/CT-TN84/16
2. Government Accession No.:
3. Recipient's Catalog No.:
4. Title and Subtitle: HELICOPTER MLS (COLLOCATED) FLIGHT TEST PLAN TO DETERMINE OPTIMUM COURSE WIDTH
5. Report Date: May 1984
6. Performing Organization Code: ACT-140
7. Author(s): James H. Enias
8. Performing Organization Report No.: DOT/FAA/CT-TN84/16
9. Performing Organization Name and Address: Federal Aviation Administration, Technical Center, Atlantic City Airport, N.J. 08405
10. Work Unit No. (TRAIS):
11. Contract or Grant No.: T0701B
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Program Engineering and Maintenance Service, Washington, D.C. 20590
13. Type of Report and Period Covered: Technical Note, February-April 1984
14. Sponsoring Agency Code:
15. Supplementary Notes:
16. Abstract

This flight test plan describes the methodology for determining an optimum azimuth and elevation course width for Microwave Landing System (MLS) approaches to a collocated MLS installation at a heliport. The flights will be conducted at the Federal Aviation Administration (FAA) Technical Center, Atlantic City Airport, New Jersey, using a UH-1H helicopter. This effort will provide a data base for determining the course width to be utilized in future helicopter MLS flight test activity scheduled to be conducted at the Technical Center. The data collection and data reduction and analysis of the flight test data are discussed, and a schedule for the completion of the associated tasks is presented.

17. Key Words: Microwave Landing System (MLS); Terminal Instrument Procedures (TERPS)
18. Distribution Statement: Document is on file at the Technical Center Library, Atlantic City Airport, N.J. 08405
19. Security Classif. (of this report): Unclassified
20. Security Classif. (of this page): Unclassified
21. No. of Pages: 20
22. Price:

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN84/20		

4. Title and Subtitle
HELICOPTER MLS COLLOCATED FLIGHT TEST FOR TERPS DATA

5. Report Date
June 1984

6. Performing Organization Code
ACT-140

7. Author(s)
James H. Enias, Paul Maenza, and Donald P. Pate

8. Performing Organization Report No.
DOT/FAA/CT-TN84/20

9. Performing Organization Name and Address
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
T07-01B

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Programming Engineering and Maintenance Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Technical Note
February-December 1984

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This flight test plan describes the methodology for a data collection flight test using the Microwave Landing System (MLS) for precision approaches to a collocated MLS installation at a heliport. The flight tests will be conducted at the Federal Aviation Administration (FAA) Technical Center, Atlantic City Airport, New Jersey, using the Center's Sikorsky S-76 helicopter. This effort will provide a data base for procedures specialists to develop departure procedures and in MLS approach procedures to a helipad. The test development, test equipment, data collection, and data reduction and analysis of the flight data are discussed. A schedule for the completion of the associated tasks is presented.

17. Key Words
TERPS
MLS

18. Distribution Statement
Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	55	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-84/22	AD-A148137	

4. Title and Subtitle
HELIPORT SNOW AND ICE CONTROL
METHODS AND GUIDELINES

5. Report Date
August 1984

6. Performing Organization Code

7. Author(s)
J.B. McKinley and R.B. Newman

8. Performing Organization Report No.

9. Performing Organization Name and Address
Systems Control Technology Inc.
2326 So. Congress Avenue, Suite 2-A
West Palm Beach, Florida 33406

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DTFA01-80-C-10080

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

13. Type of Report and Period Covered
Final Report

14. Sponsoring Agency Code
APM-720

15. Supplementary Notes

16. Abstract

Guidelines for snow and ice control on heliports are presented for the purpose of both enhancing the operational utility of heliports, and employing the unique capabilities of the rotorcraft to the maximum extent. These guidelines consider manual methods of snow and ice control such as plowing and chemical application, and automated methods through pavement heating systems. Cost and design considerations are provided for each system. Benefit/cost decision guidelines are provided with estimated annual operating cost data for 32 U.S. cities, and six snow and ice control methods. In addition, selection guidelines provide a methodology to assist heliport planners and designers with the selection of the most appropriate snow and ice control system.

HELIPORT
SNOW
ICE
DEICING CHEMICALS
PAVEMENT HEATING SYSTEMS

18. Distribution Statement
This document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	59	

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Technical Report Documentation Page

1. Report No. DOT/FAA/PM-84/23	2. Government Accession No. AD-A148967	3. Recipient's Catalog No.
4. Title and Subtitle Structural Design Guidelines for Heliports		5. Report Date October 24, 1984
		6. Performing Organization Code
7. Author(s) C.W.Schwartz, M.W.Witczak, and R.B.Leahy		8. Performing Organization Report No.
9. Performing Organization Name and Address Department of Civil Engineering University of Maryland College Park, MD 20742		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. A01-80-10080
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Program Engineering & Maintenance Service Washington, D.C. 20591		13. Type of Report and Period Covered Final Report 12/5/83 - 9/10/84
		14. Sponsoring Agency Code APM-740

15. Supplementary Notes

Contract to: Systems Control Technology, Inc.
2326 S. Congress Ave., Suite 2-A
West Palm Beach, Florida 33406

16. Abstract

Current structural design guidelines for heliports are analyzed using data obtained from the literature and from surveys of helicopter manufacturers, heliport design consultants, and heliport operators. Primary topics of interest in these analyses are the loads on heliport structures caused by helicopter hard landings, rotor downwash, and helicopter vibrations. A new analysis, based on reliability theory, is proposed for determining the helicopter hard landing load magnitudes appropriate for structural design. Results from this analysis indicate that the current FAA heliport structural design guidelines are adequate for medium to high volume heliports and conservative for low volume facilities. Additional analyses indicate that rotor downwash pressures and helicopter-induced vibrations are not critical loading conditions for most heliport structures. Guidelines for appropriate load combinations for heliport structural design are also presented.

17. Key Words Heliports; Landing Loads; Gear Loads; Helicopter Downwash; Helicopter Vibrations	18. Distribution Statement This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	116	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-84/25	AD-A153512	
4. Title and Subtitle EVALUATING WIND FLOW AROUND BUILDINGS ON HELIPORT PLACEMENT		5. Report Date November 1984
		6. Performing Organization Code
		8. Performing Organization Report No.
7. Author(s) J.B. McKinley		
9. Performing Organization Name and Address Systems Control Technology, Inc. Champlain Technology Industries Division 2326 South Congress Avenue, Suite 2-A West Palm Beach, Florida 33406		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFA01-80-C-10080, Mod.31
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Program Engineering & Maintenance Service Washington, D.C. 20591		13. Type of Report and Period Covered Final Report Sept. 1983 through Aug. 1984
		14. Sponsoring Agency Code APM-720

15. Supplementary Notes

16. Abstract

This report presents a heliport wind assessment methodology for evaluating and potentially minimizing the influences of building-induced wind on heliport operations.

Descriptions and illustrations of wind flow patterns and characteristics for both isolated and multiple building configurations are provided to assist heliport planners, operators, and helicopter pilots in understanding the problems associated with building-induced winds. Based on geometric flow patterns, general guidelines for ground level and rooftop heliport placement are provided.

Additional guidelines for determining the area of wind influence about isolated and multiple building configurations are detailed. Rules for calculating the distance from the sides of buildings for heliport siting is provided, as well as, rules for calculating the area of influence from any wind direction. Lastly, rules are defined for calculating the area of influence of buildings with respect to the prevailing climatic wind conditions.

Recommendations are delineated for further data gathering and evaluation to validate and enhance the heliport wind assessment methodology.

17. Key Words	18. Distribution Statement
Heliport Helicopters Wind Flow Turbulence Downstream Wakes	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	42	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-84/31	AD-A149539	

4. Title and Subtitle	5. Report Date
Very Short Range Statistical Forecasting of Automated Weather Observations	November 1984
	6. Performing Organization Code
	8. Performing Organization Report No.

7. Author(s)

Robert G. Miller, Ph.D.

9. Performing Organization Name and Address

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Systems Development
Techniques Development Lab., 8060 13th St., S.S., MD 20910

10. Work Unit No. (TRAIS)

156-410-010

11. Contract or Grant No.

DTFA01-83-Y-20625

12. Sponsoring Agency Name and Address

U.S. Department of Transportation
Federal Aviation Administration
Program Engineering and Maintenance Service
Helicopter Program, APM-720; Washington, D.C. 20591

13. Type of Report and Period Covered

INTERIM REPORT
September 1983-Oct. 1984

14. Sponsoring Agency Code

FAA/APM-720

15. Supplementary Notes

Prepared under FAA/NWS Interagency Agreement No. DTFA01-83-Y-20625, managed by Weather Sensors Program, APM-440, Communications and Surveillance Division

16. Abstract

A procedure is developed for providing weather forecasting guidance over the short period between 1 to 60 minutes. It uses automated surface observation elements as predictors and predictands. The same equations project probabilistic predictions iteratively minute-by-minute. The model is founded on a Markov assumption and utilizes multivariate linear regression as the statistical operator. Details are given on how the model is constructed and how it compares with other objective methods such as climatology and persistence. Tests are performed on a new nonlinear approach.

17. Key Words	18. Distribution Statement
Short-range forecasts Statistical forecasts Markov GEM Multivariate linear regression	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	25	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN84/34		

4. Title and Subtitle	5. Report Date
HELICOPTER IFR LIGHTING AND MARKING PRELIMINARY TEST RESULTS	July 1984
	6. Performing Organization Code
7. Author(s) Paul Jones	8. Performing Organization Report No. DOT/FAA/CT-TN84/34
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	13. Type of Report and Period Covered Technical Note
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Various approach lighting configurations, intended to support helicopter Instrument Flight Rules (IFR) approach and landing operations, have been developed and tested at the Federal Aviation Administration (FAA) Technical Center, Atlantic City Airport, New Jersey and at Fort George G. Meade, Maryland. This report outlines details of the test and evaluation procedure and provides preliminary test results. It also contains recommendations for a nonprecision helicopter approach lighting system suitable for installation and inservice evaluation at IFR demonstration heliports. The proposed system includes front and rear approach lights, enhanced pad perimeter lights, wing bars, and inset touchdown area lights.

17. Key Words	18. Distribution Statement
Heliports Visual Guidance Approach Lighting	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	18	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN84/40		

4. Title and Subtitle	
HELIPORT MLS SITING EVALUATION	5. Report Date: January 1985
	6. Performing Organization Code: ACT-140
7. Author(s): Scott B. Shollenberger	8. Performing Organization Report No.: DOT/FAA/CT-TN84/40
9. Performing Organization Name and Address: Federal Aviation Administration, Technical Center, Atlantic City Airport, N.J. 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: T0701B
	13. Type of Report and Period Covered: Technical Note October 1984
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Program Engineering and Maintenance Service, Washington, D.C. 20591	14. Sponsoring Agency Code: APM-720

15. Supplementary Notes The Heliport MLS Siting Evaluation Program was conducted jointly by the FAA Technical Center and the U.S. Army Avionics Research and Development Activity (AVRADA) through FAA/AVRADA Interagency Agreement DTFA01-80-Y-10530. FAA Technical Center Project Engineer: Scott Shollenberger/AVRADA Project Engineer/Pilot: Paul S. Demko.

16. Abstract

This report documents a series of tests designed to provide recommended range of locations for a landing pad which would be satisfactory sites for Microwave Landing Systems (MLS) precision heliport approaches during instrument meterological conditions (IMC) for minimally equipped helicopters. The dependent variable for this experiment was deceleration distance and the independent variables were decision height (DH), range rate, and elevation angle. Twenty-eight data flights, using 56 flight hours and eight subject pilots to complete, were conducted at the Federal Aviation Administration (FAA) Technical Center parallel to runway 13/31. The subject pilots were required to fly hooded, inbound 125° or 310° azimuth, through elevation angle capture and DH, to a visual deceleration landing to full stop. Real estate availability was not considered as a constraint in this study. The data show that as the elevation angle to a desired DH is increased, an angle will be reached which requires that the antenna system be moved from a location adjacent to the heliport to a location in front of the heliport. This separation distance increases as a function of increasing elevation angle (i.e., the helicopter must fly past the MLS antenna to reach the heliport). For a given elevation angle, as the DH is decreased, a DH will be reached which requires that the MLS antenna again be moved from a location adjacent to the heliport to locations in front of the heliport. This separation increases in distance as a function of decreasing decision height. In situations where real estate is limited, steeper angle approaches and lower minima could be obtained by increasing the capabilities of the aircraft and/or the crew.

17. Key Words	18. Distribution Statement
Heliport MLS Collocated MLS/Heliport	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	74	

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN84/47	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle GLOBAL POSITIONING SYSTEM PERFORMANCE DURING FAA HELICOPTER TEST ON ROTOR EFFECTS		5. Report Date January 1985
		6. Performing Organization Code ACT-140
7. Author(s) Jerome T. Connor and George Paolacci		8. Performing Organization Report No. DOT/FAA/CT-TN84/47
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T0704A
12. Sponsoring Agency Name and Address Federal Aviation Administration Programming Engineering and Maintenance Service Washington, D.C. 20590		13. Type of Report and Period Covered Technical Note June - September 1984
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report covers the 1984 Federal Aviation Administration (FAA) tests using a single channel Global Positioning System (GPS) receiver under the turning rotor blades of a Sikorsky twin-turbine 4-composite bladed S-76 Helicopter and an Army 2-metal bladed UH-1H helicopter. The report cites the performance of the Magnavox Z-Set GPS receiver during acquisition and operation at various rotor speeds on the ground.

17. Key Words	18. Distribution Statement
NAVSTAR GPS Z-Set Helicopter/GPS	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	21	

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
PM-85-2-LR		

4. Title and Subtitle	5. Report Date
Heliport Design Guide, Workshop Report Volume I: Executive Summary	January 1985
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control Technology, Inc. West Palm Beach, Florida 33406	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DTFA01-80-C-10080
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration 800 Independence Ave., S.W. Washington, D.C. 20591	13. Type of Report and Period Covered Final Report November 27-29, 1984
	14. Sponsoring Agency Code APM-720

15. Supplementary Notes

16. Abstract During the last 18 months, the coordinated efforts of the Federal Aviation Administration (FAA), state/local governments, and the helicopter industry have been directed toward the upgrading of the existing Heliport Design Guide. In response to industry's request, the FAA sponsored a 3 day workshop on November 27-29, 1984. The major objective was to assemble a cross section of the helicopter community to discuss the critical issues related to IFR/VFR heliport design and to document industry's position as an input to a revised Heliport Design Guide. The open workshop was widely attended and the 80 participants came from all aspects of the helicopter community: regulators, manufacturers, operators, consultants, and the aviation trade press. Following a plenary session, the issues were addressed individually in one of four working groups: 1. Flight Operations, Airspace and Maneuver Area, 2. Support Facilities and Services, 3.Ground Safety, 4. Planning and Environmental Aspects. Critical issues were assigned to these smaller working groups in order to facilitate meaningful treatment of each identified subject.

Upon completion of working group deliberations, the four group chairmen presented their results at a second plenary session in order to achieve a broader consensus. This report contains the industry recommendations which came out of this workshop. The three volume report is laid out as follows:

Volume I: Executive Summary
Volume II: Appendixes
Volume III: Viewgraphs

17. Key Words	18. Distribution Statement
Heliport Design Guide	This document will be distributed to all who attended the workshop. A limited number of additional copies are also available from the sponsering agency (see block 12).

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	57	

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Technical Report Documentation Page

1. Report No. PM-85-3-LR	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Heliport Design Guide, Workshop Report Volume II: Appendixes		5. Report Date January 1985
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control Technology, Inc. West Palm Beach, Florida 33406		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFA01-80-C-10080
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration 800 Independence Ave., S.W. Washington, D.C. 20591		13. Type of Report and Period Covered Final Report November 27-29, 1984
		14. Sponsoring Agency Code APM-720
15. Supplementary Notes		

16. Abstract During the last 18 months, the coordinated efforts of the Federal Aviation Administration (FAA), state/local governments, and the helicopter industry have been directed toward the upgrading of the existing Heliport Design Guide. In response to industry's request, the FAA sponsored a 3 day workshop on November 27-29, 1984. The major objective was to assemble a cross section of the helicopter community to discuss the critical issues related to IFR/VFR heliport design and to document industry's position as an input to a revised Heliport Design Guide. The open workshop was widely attended and the 80 participants came from all aspects of the helicopter community: regulators, manufacturers, operators, consultants, and the aviation trade press. Following a plenary session, the issues were addressed individually in one of four working groups: 1. Flight Operations, Airspace and Maneuver Area, 2. Support Facilities and Services, 3. Ground Safety, 4. Planning and Environmental Aspects. Critical issues were assigned to these smaller working groups in order to facilitate meaningful treatment of each identified subject.

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Volume II: Appendixes
Volume III: Viewgraphs

17. Key Words Heliport Design Guide		18. Distribution Statement This document will be distributed to all who attended the workshop. A limited number of additional copies are also available from the sponsoring agency (see block 12).	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 130	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
PM-85-4-LR		

4. Title and Subtitle	5. Report Date
Heliport Design Guide, Workshop Report Volume III: Viewgraphs	January 1985
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control Technology, Inc. West Palm Beach, Florida 33406	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DTFA01-80-C-10080
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration 800 Independence Ave., S.W. Washington, D.C. 20591	13. Type of Report and Period Covered Final Report November 27-29, 1984
	14. Sponsoring Agency Code APM-720

15. Supplementary Notes

16. Abstract During the last 18 months the coordinated efforts of the Federal Aviation Administration (FAA), state/local governments, and the helicopter industry have been directed toward the upgrading of the existing Heliport Design Guide. In response to industry's request, the FAA sponsored a 3 day workshop on November 27-29, 1984. The major objective was to assemble a cross section of the helicopter community to discuss the critical issues related to IFR/VFR heliport design and to document industry's position as an input to a revised Heliport Design Guide. The open workshop was widely attended and the 80 participants came from all aspects of the helicopter community: regulators, manufacturers, operators, consultants, and the aviation trade press. Following a plenary session, the issues were addressed individually in one of four working groups: 1. Flight Operations, Airspace and Maneuver Area, 2. Support Facilities and Services, 3. Ground Safety, 4. Planning and Environmental Aspects. Critical issues were assigned to these smaller working groups in order to facilitate meaningful treatment of each identified subject.

Upon completion of working group deliberations, the four group chairmen presented their results at a second plenary session in order to achieve a broader consensus. This report contains the industry recommendations which came out of this workshop. The three volume report is laid out as follows:

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Volume III: Viewgraphs

17. Key Words	18. Distribution Statement
Heliport Design Guide	This document will be distributed to all who attended the workshop. A limited number of additional copies are also available from the sponsering agency (see block 12).

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	85	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/5		

4. Title and Subtitle	5. Report Date
GULF OF MEXICO HELICOPTER LORAN C STABILITY STUDY	April 1985
	6. Performing Organization Code: ACT-140
7. Author(s): Rosanne M. Weiss	8. Performing Organization Report No.: DOT/FAA/CT-TN85/5
9. Performing Organization Name and Address: Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: T0701C
12. Sponsoring Agency Name and Address: Federal Aviation Administration Technical Center Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered: Technical Note May 1983 - January 1985
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report discusses the results of a 1-year test conducted by the Federal Aviation Administration (FAA) Technical Center in the Gulf of Mexico to determine both long and short term stability of Loran C signals in this region for helicopters on nonprecision approaches.

The data collected were analyzed at the Technical Center. Plots of the data demonstrate the long and short term stability and, based on the analysis, conclusions concerning operations in the Gulf of Mexico were made.

17. Key Words	18. Distribution Statement
Loran C Line of Position Error Ellipses Geometric Contours	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	70	

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Technical Report Documentation Page

1. Report No. DOT/FAA/PM-85/6	2. Government Accession No. AD-A155415	3. Recipient's Catalog No.
4. Title and Subtitle HELICOPTER USER SURVEY - TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)		5. Report Date April 1985
		6. Performing Organization Code
7. Author's) F.R. Taylor and R.J. Adams		8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control Technology, Inc. 2326 So. Congress Ave., Suite 2A West Palm Beach, Florida 33406		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFA01-80-C-10080/Mod.049
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration 800 Independence Ave. Washington, D.C. 20591		13. Type of Report and Period Covered Final Report Oct.1983 - Feb. 1985
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This document describes the data collection methodology, and the results obtained from the Traffic Alert and Collision Avoidance System (TCAS) User Survey. The survey was conducted during the fall, spring and early summer of 1984. The survey examined helicopter operator and pilot responses in three particular areas of interest: 1) The nature of helicopter near mid-air collision encounters, 2) Pilot Display Preferences, and 3) User price thresholds for a helicopter TCAS.

The survey revealed that only a small percentage of near mid-air collisions involving helicopters are reported, although pilots assert that mid-air collisions pose a significant hazard to flight safety. This report contains breakdowns, by operator group, of significant characteristics of helicopter operations and their associated NMAC hazards which should be addressed in the design of a helicopter specific TCAS.

17. Key Words TCAS NMAC Helicopter	18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 95	22. Price

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-85/7	AD-A157367	

4. Title and Subtitle	5. Report Date
MICROWAVE LANDING SYSTEMS FOR HELIPORT OPERATORS, OWNERS AND USERS	June 1985
	6. Performing Organization Code
7. Author(s): Kristen J. Venezia, Edwin D. McConkey	8. Performing Organization Report No.
9. Performing Organization Name and Address: Systems Control Technology, Inc., 2326 S. Congress Ave., Suite 2-A, West Palm Beach, FL 33406	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: DTFA01-80-C-10080
12. Sponsoring Agency Name and Address: Federal Aviation Administration, Aircraft Safety and Airport Technology, Helicopter Program, APM-720, 800 Independence Ave., S.W., Washington, D.C. 20591	13. Type of Report and Period Covered: FINAL REPORT
	14. Sponsoring Agency Code: APM-720

15. Supplementary Notes

16. Abstract

This document contains information on the utilization of the Microwave Landing System (MLS) at heliports and helipads. It was designed to familiarize heliport operators and users with the features of the MLS and its capabilities in supporting heliport operations. For this reason the major sections of the document present information on MLS siting, operational characteristics, selecting and specifying an MLS system. In addition, other sections provide additional MLS information to familiarize pilots with MLS avionics, pilot training requirements and aircraft performance considerations.

17. Key Words	18. Distribution Statement
Microwave Landing System Helicopters Heliports Rotorcraft	Document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	52	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-85/8	AD-A163483	

4. Title and Subtitle	5. Report Date
VHF-AM Communications Equipment Selection and Installation Practices for Helicopters	September 1985
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
E.H. Bolz, L.D. King	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Systems Control Technology, Inc. 2326 S. Congress Ave., Suite 2-A West Palm Beach, FL 33406	11. Contract or Grant No. DTFA01-80-C-10080
	13. Type of Report and Period Covered Final Report September 1983-March 1984
12. Sponsoring Agency Name and Address Federal Aviation Administration Cockpit Technology Program, APM-430 800 Independence Avenue, S.W. Washington, D.C. 20591	14. Sponsoring Agency Code FAA-APM-430, APM-720

15. Supplementary Notes

16. Abstract

This publication addresses the problems helicopter operators face when using VHF communications within typical operating environments where coverage by the network of ground stations may be deficient. This is of particular interest to IFR helicopter operators. The specific reasons why communications effectiveness can be limited in mountainous or remote regions, considering typical low helicopter operating altitudes, are reviewed. Recommendations to operators for improving the airborne VHF installation, and therefore improving its coverage capabilities, are presented.

Several installation-related factors are addressed. These include the characteristics of the hardware, i.e. the transceiver and the antenna, and the characteristics of the installation, including antenna installation and resulting coverage pattern, the cable run, the effects of signal availability and ways of maximizing the capture of the available signal. A set of procedures is presented which allows operators to evaluate numerically the benefit in terms of signal strength or sensitivity they may expect given that they make specific improvements to a given actual, or planned, installation.

17. Key Words	18. Distribution Statement
VHF Communications ATC Communications Helicopter IFR Helicopter Antennas Low Altitude Communications	Document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	47	

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Technical Report Document Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-85/11	AD-A158777	

4. Title and Subtitle	5. Report Date
ANALYSIS OF ROTORCRAFT CRASH DYNAMICS FOR DEVELOPMENT OF IMPROVED CRASHWORTHINESS DESIGN CRITERIA	June 1985
	6. Performing Organization Code
	8. Performing Organization Report No. TR-83414A
7. Author(s) J. W. Coltman, A. O. Bolukbasi, D. H. Laananen	10. Work Unit No. (TRAIS)
9. Performing Organization Name and Address Simula Inc. 2223 S. 48th Street Tempe, Arizona 85282	11. Contract or Grant No. DTFA03-81-C-00035
	13. Type of Report and Period Covered FINAL March 1981 - May 1985
12. Sponsoring Agency Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	14. Sponsoring Agency Code ACT-330

15. Supplementary Notes

16. Abstract

A review was conducted of U.S. civil helicopter accidents occurring between 1974 and 1978 to determine impact conditions and injuries to the occupants. This report describes the distribution of impact conditions. Also, six typical impact scenarios were developed to represent classes of accidents. A rank-ordered analysis of crash hazards is presented. The report also contains an evaluation of computer techniques available for structural crash dynamics simulation and a comparison of the civil and military helicopter crash environments. Recommended crashworthiness design criteria for civil rotorcraft are presented.

17. Key Words		18. Distribution Statement
Aircraft	Human Tolerance	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161
Injury	Crash Environment	
Rotorcraft	Crash Scenario	
Crashworthiness	Impact Dynamics	
Design Criteria		

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	193	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/15		

4. Title and Subtitle COURSE WIDTH DETERMINATION FOR COLLOCATED MLS AT HELIPORTS	5. Report Date December 1985 6. Performing Organization Code ACT-140
7. Author(s) James H. Enias	8. Performing Organization Report No. DOT/FAA/CT-TN85/15
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. T07-01B
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Technical Note May - July 1984 14. Sponsoring Agency Code APM-720

15. Supplementary Notes

16. Abstract

This report describes the results of an inflight evaluation of azimuth (AZ) and elevation (EL) course widths associated with a Microwave Landing System (MLS) approach to a helipad. The flight test data were recorded during straight-in precision approaches using raw-data course guidance information to fly 3°, 6°, and 9° elevation angles to a collocated MLS sited at the helipad. The flight test was conducted in an Army UH-1H helicopter provided through an Army/Federal Aviation Administration (FAA) interagency agreement. The purpose of this program was to determine an optimum course width for future flight test evaluations of MLS at the Technical Center.

The data analysis demonstrated that the optimum azimuth course width for an approach to an MLS collocated at the helipad is between ±3.25° and ±3.75° that the optimum elevation course width is the magnitude of the selected elevation angle divided by 3 (EL/3). This document describes the flight test facilities, methodology, and presents an analysis of the flight test data.

17. Key Words	18. Distribution Statement
MLS Helicopter TERPS Heliport	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	125	

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/17	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle NONPRECISION APPROACHES IN THE NORTHEAST CORRIDOR USING SECOND GENERATION LORAN C RECEIVERS		5. Report Date May 1985
		6. Performing Organization Code ACT-140
7. Author(s) Barry Billmann, John Morrow, and Christopher Wolf		8. Performing Organization Report No. DOT/FAA/CT-TN85/17
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T0701D
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590		13. Type of Report and Period Covered Technical Note May-September 1983
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report documents the results of helicopter nonprecision approaches using second generation Loran C receivers. The approaches were made to five airports in the Northeast Corridor. Six different Loran C receivers were used throughout the study. Results of this study were comparable to previous Loran C helicopter nonprecision Area Navigation (RNAV) approaches which were flown in the Northeast Corridor. When the receivers were area calibrated the navigation systems crosstrack error and along-track error met requirements of Advisory Circular (AC) 90-45A. Additionally, the flight technical error which results when Loran C approaches are made with a helicopter met requirements of AC 90-45A.

17. Key Words Helicopter Loran C Nonprecision Approaches Flight Technical Error	18. Distribution Statement Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	44	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/23		

4. Title and Subtitle TEST PLAN FOR SITING, INSTALLATION, AND OPERATIONAL SUITABILITY OF THE AUTOMATED WEATHER OBSERVING SYSTEM (AWOS) AT HELIPORTS	5. Report Date June 1985 6. Performing Organization Code ACT-140
7. Author(s) Rene' A. Matos	8. Performing Organization Report No. DOT/FAA/CT-TN85/23
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. T07-05A
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Test Plan January 1985 - January 1986 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

An Automated Weather Observing System (AWOS) will be installed at the Federal Aviation Administration (FAA) Technical Center's interim Concept Development Heliport, Atlantic City Airport, New Jersey. This test plan describes the methodology for installation and determination of optimum siting of an AWOS at a heliport. The resulting siting and installation criteria will be incorporated in DOT/FAA Order 6560, "Installation and Siting Criteria for Automated Weather Observing System (AWOS)," paragraph 14, which has been reserved for applicable heliports. Data collection, reduction, and analysis of test data are discussed and a schedule for completion of tasks is presented.

17. Key Words	18. Distribution Statement
Automated Weather Observing System (AWOS)	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	34	

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/24	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle HELICOPTER TERMINAL INSTRUMENT APPROACH PROCEDURES (VOR/ILS)		5. Report Date October 1985
		6. Performing Organization Code ACT-140
7. Author(s) Christopher J. Wolf		8. Performing Organization Report No. DOT/FAA/CT-TN85/24
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T0701A
		13. Type of Report and Period Covered Technical Note February 1982 - May 1983
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report documents the Federal Aviation Administration (FAA) Techical Center's Helicopter Terminal Instrument Approach Procedures (TERPS) project. This project was undertaken in response to the Aviation Standards National Field Office (AVN) to provide data for use in streamlining and updating chapter 11 of the TERPS manual.

Data were collected for Instrument Landing System (ILS) and very high frequency omni-directional radio range (VOR) precision and nonprecision approaches. Data collection was performed using helicopters from various weight classes.

After the data were collected, it was reduced and formatted and forwarded to AVN for analysis and use in the updating of helicopter TERPS criteria.

17. Key Words VOR, HELICOPTER, ILS, TERPS		18. Distribution Statement Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 388	22. Price

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Technical Report Documentation Page

1. Report No.
DOT/FAA/CT-85/26
(TR-85-F-11)

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
Summary of Artificial and Natural Icing Tests Conducted on U.S. Army Aircraft from 1974 to 1985

5. Report Date
July 1986

6. Performing Organization Code
AMSAV-E

7. Author(s)
Harry W. Chambers and John Y. Adams

8. Performing Organization Report No.
TR-85-F-11

9. Performing Organization Name and Address
U.S. Army Aviation Systems Command
ATTN: AVSAV-E
4300 Goodfellow Boulevard
St. Louis, MO 63120-1798

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
DTFA03-80-A-00199

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration Technical Center
Atlantic City Airport, NJ 08405

13. Type of Report and Period Covered
Final Summary Report
1974-1985

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract
The U.S. Army Aviation Systems Command (USAAVSCOM) conducts airworthiness qualification testing on aircraft under artificial and natural icing conditions. A JCH-47C helicopter with a Helicopter Icing Spray System (HISS) installed is used for generating a simulated natural icing environment. The artificial icing tests are followed by natural icing tests to assure a wide variety of flight conditions are tested and to verify artificial icing test results. The JCH-47C/HISS has been used since 1974 for conducting research, engineering, development, and qualification testing for U.S. Army, U.S. Navy, NASA, and various contractor aircraft. The USAAVSCOM has compiled an extensive artificial and natural icing test data base. The data is summarized in this report. Detailed time histories of selected natural icing encounters have been provided under separate cover to the Federal Aviation Administration (FAA).

This report documents unclassified U.S. Army, other U.S. Government agencies, and commercial icing test programs. Also discussed is the use of deice and anti-ice systems; the impact of ice accretion and shedding characteristics, performance considerations, stability and control, and vibration characteristics; and the cloud parameters measurement equipment and test aircraft instrumentation used for documenting test data. The test methodology and requirements used for qualifying aircraft for flight into icing conditions, instrumentation, and special equipment are summarized, and the details for test conducted are contained in the references. The report documents in part 14 years of U.S. Army experience in conducting in-flight aircraft icing tests and is provided to the FAA under interagency agreement in the preparation of manuals and other documents relative to the certification of civil aircraft as appropriate.

17. Key Words
Helicopter Icing
Aircraft Icing
Liquid Water Content
Supercooled Clouds
Airworthiness Qualification
Certification

18. Distribution Statement
Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	206	

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA/DOT/PM-85/30	AD-A169076	

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code
Pilot Evaluation of TCAS in the Long Ranger Helicopter	
7. Author(s)	**8. Performing Organization Report No.**
John W. Andrews	ATC-136
9. Performing Organization Name and Address	**10. Work Unit No.**
Massachusetts Institute of Technology Lincoln Laboratory P.O. Box 73 Lexington, MA 02173-0073	**11. Contract or Grant No.** DOT-FA77WAI-817
12. Sponsoring Agency Name and Address	**13. Type of Report and Period Covered**
Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20951	Project Report **14. Sponsoring Agency Code**

15. Supplementary Notes

The work reported in this document was performed at Lincoln Laboratory, a center for research operated by Massachusetts Institute of Technology, under Air Force Contract F19628-85-C-0002.

16. Abstract

A specially modified version of the Traffic Alert and Collision Avoidance System (TCAS) was installed in a Bell Long Ranger helicopter in order to investigate the feasibility of TCAS operation in rotorcraft. This installation employed TCAS air-to-air surveillance to provide automated traffic advisories that were displayed in the cockpit on a color cathode ray tube display.

As part of this study, 12 subject pilots evaluated the utility of the installation through brief test flights in the vicinity of a major airport. Among the topics investigated were the rate of alarms, the computer logic for issuing advisories, the bearing accuracy, and the display symbology. Several recommendations for adapting TCAS to the rotorcraft environment resulted from the testing.

17. Key Words	18. Distribution Statement
TCAS Collision avoidance helicopter traffic advisories	Document is available to the public through the National Technical Information Service. Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/49	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle TEST PLAN FOR ROTORCRAFT TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)		5. Report Date December 1985
		6. Performing Organization Code ACT-140
7. Author(s) Albert J. Rehmann		8. Performing Organization Report No. DOT/FAA/CT-TN85/49
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T0702G
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590		13. Type of Report and Period Covered Technical Note June 1985 - January 1986
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This test plan outlines a three-part development effort for a Traffic Alert and Collision Avoidance System (TCAS) for helicopters. The installation and planned flight test of a TCAS experimental unit (TEU) in a composite aircraft, the Sikorsky S-76, are described.

17. Key Words	18. Distribution Statement
TCAS Collision Avoidance	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/53		

4. Title and Subtitle
VALIDATION OF MLS SITING CRITERIA FOR MLS STEEP ANGLE APPROACHES TO A HELIPORT

5. Report Date
November 1985

6. Performing Organization Code
ACT-140

7. Author(s)
Scott B. Shollenberger

8. Performing Organization Report No.
DOT/FAA/CT-TN85/53

9. Performing Organization Name and Address
Federal Aviation Administration
Technical Center
Atlantic City Airport, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
T0701B

12. Sponsoring Agency Name and Address
Federal Aviation Administration
Program Engineering and Maintenance Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Technical Note
July 1985

14. Sponsoring Agency Code
APM-720

15. Supplementary Notes The Heliport MLS Siting Evaluation program was conducted jointly by the FAA Technical Center and the U.S. Army Avionics Research and Development Activity (AVRADA) through FAA/AVRADA Interagency Agreement DTFA01-80-Y-10530. FAA Technical Center Project Engineer - Scott Shollenberger, AVRADA Project Engineer/Pilot - Paul S. Demko.

16. Abstract

This report documents a series of tests designed to provide a recommended range of locations for a Microwave Landing System (MLS) at a heliport to support precision approaches in instrument meterological conditions (IMC) for minimally equipped helicopters. An objective of the tests was to achieve the lowest practical decision heights (DH's). Eight subject pilots completed 36 data flights totalling 67 hours of flight time. The subjects flew simulated IMC approaches through glidepath capture and DH, to a visual deceleration landing to a full stop at the Federal Aviation Administration Technical Center heliport. Results show that for a 90-knot approach (to any of the DH's) the separation distance between the collocated MLS and the heliport (i.e., the MLS in front of the helipad) is 1400 feet. For a 60-knot approach the separation distance is 550 feet. Data also illustrated that for the 90-knot approaches a lateral separation of the inbound course centerline from the heliport centerline of 600 feet is satisfactory, and 400 feet is the maximum lateral separation for 60 knots. Maximum recommended glidepath angles were between 7° and 10°, depending on approach speed and DH.

17. Key Words
Steep Angle Approaches/Heliport
Heliport MLS
Collocated MLS/Heliport
Siting Criteria/MLS

18. Distribution Statement
Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/55		

4. Title and Subtitle	5. Report Date October 1985 6. Performing Organization Code ACT-140
PILOT INFLIGHT EVALUATION OF MLS PROCEDURES AT HELIPORTS	
7. Author(s) James H. Enias	8. Performing Organization Report No. DOT/FAA/CT-TN85/55
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. T0701B
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Technical Note September 1985 14. Sponsoring Agency Code APM-720

15. Supplementary Notes

16. Abstract

This report describes the Helicopter Microwave Landing System (MLS) Collocated Flight Test project recently completed by the Guidance and Airborne Systems Branch at the Federal Aviation Administration (FAA) Technical Center. It describes the flight test facilities, methodology, and addresses topics such as how flight test data are collected and its application. It also describes each of the helicopter procedures flown during the project and provides an analysis of the pilot's subjective opinions concerning the acceptability and workload associated with these procedures.

It was concluded that subject pilots were able to fly single pilot raw data guided MLS precision approaches at elevation (glidepath) angles ranging from 3° to 9° to decision heights within 0.5 nmi of the helipad, when the azimuth angular course width was set to $\pm 3.6°$, and the elevation angular course width was set to the magnitude of the selected elevation angle divided by 3 (SEL/3).

The data presented herein also suggests that some pilot training on the techniques of tracking steep glidepaths and the importance of speed control for precision approaches to a helipad are required.

17. Key Words	18. Distribution Statement
MLS TERPS Helicopter Heliport	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	89	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN85/58	AD-A165073	

4. Title and Subtitle	5. Report Date
TECHNICAL SUPPORT OF THE WALL STREET/BATTERY PARK CITY HELIPORT MLS PROJECT	December 1985
	6. Performing Organization Code ACT-140
7. Author(s) Barry R. Billmann, James H. Enias, and Michael Webb	8. Performing Organization Report No. DOT/FAA/CT-TN85/58
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transporation Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Technical Note January-June 1985 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

During the winter and spring of 1985, the Federal Aviation Administration (FAA) Eastern Region in conjunction with the Guidance and Airborne Systems Branch at the FAA Technical Center conducted a demonstration of a Microwave Landing System (MLS) located at a downtown heliport.

This report describes both the industry/user and FAA Technical Center activities during the evaluation period. It describes the evaluation methodology and addresses topics concerning both technical and operational issues. It also describes the helicopter procedures flown during this evaluation and provides an analysis of signal coverage and the user's subjective opinions concerning the acceptability and perceived workload associated with these procedures.

It was concluded that MLS to heliports is a viable asset to the helicopter Instrument Flight Rules (IFR) community, however, its full benefits may not be realized in the Battery Park/Wall Street area without revisiting the necessity and demand for the New York Terminal Control Area (TCA) Visual Flight Rules (VFR) operating exclusion area.

17. Key Words	18. Distribution Statement
MLS Helipad Helicopter Heliport Pilot Workload	Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/60	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ROTORCRAFT TCAS EVALUATION GROUP 1 RESULTS		5. Report Date November 1985
		6. Performing Organization Code ACT-140
7. Author(s) Albert J. Rehmann		8. Performing Organization Report No. DOT/FAA/CT-TN85/60
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T1101B
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590		13. Type of Report and Period Covered Technical Note June-July 1985
		14. Sponsoring Agency Code APM-330
15. Supplementary Notes		

16. Abstract

Results of part 1 of a three-part Traffic Alert and Collision Avoidance System (TCAS) evaluation are contained in this report. Part 1 evaluation consisted of the installation and initial checkout of a TCAS Experimental Unit (TEU) in a Sikorsky S-76 helicopter.

The results show that the installation was verified except for an unintended 15 decibel (dB) loss in the top mounted antenna.

17. Key Words TCAS Collision Avoidance Helicopter	18. Distribution Statement Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/63	2. Government Accession No. AD-A1637[illegible]	3. Recipient's Catalog No.
4. Title and Subtitle COMPUTED CENTERLINE MLS APPROACH DEMONSTRATION AT THE WASHINGTON NATIONAL AIRPORT		5. Report Date October 1985
		6. Performing Organization Code ACT-140
7. Author(s) James H. Remer		8. Performing Organization Report No. DOT/FAA/CT-TN85/63
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T0701G
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, DC 20590		13. Type of Report and Period Covered Technical Note September 1985
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report covers the design, analysis, and flight test of a Computed Centerline Microwave Landing System (MLS). This system enables final approaches to be made to runways which have azimuth units offset from the runway centerline. The system was successfully flight tested at the Federal Aviation Administration (FAA) Technical Center, Atlantic City Airport, NJ, and at the Washington National Airport. Hardware design schematics and software listings are included in addition to flight test data plots.

17. Key Words Area Navigation (RNAV) Microwave Landing System (MLS) Computed Centerline Helicopter	18. Distribution Statement This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/64	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle HELIPORT MLS CRITICAL AREA FLIGHT TESTS		5. Report Date October 1985
		6. Performing Organization Code ACT-140
7. Author(s) Robert S. Jeter		8. Performing Organization Report No. DOT/FAA/CT-TN85/64
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. T0701B
12. Sponsoring Agency Name and Address Federal Aviation Administration Program Engineering and Maintenance Service Washington, DC 20590		13. Type of Report and Period Covered Technical Note September 1985
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This Technical Note describes the methodology for data collection flight tests to determine critical area boundaries about an Microwave Landing System (MLS) facility in which unlimited operations could degrade signal integrity to user helicopters.

Test procedures, data collection, and data reduction and analysis are discussed.

17. Key Words MLS Heliport Rotorcraft	18. Distribution Statement Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN85/83	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle: ROTORCRAFT TCAS EVALUATION BENCH TEST REPORT	5. Report Date: March 1986
	6. Performing Organization Code: ACT-140
7. Author(s): Arthur W. Cushman, Albert J. Rehmann, and John Warren	8. Performing Organization Report No.: DOT/FAA/CT-TN85/83
9. Performing Organization Name and Address: Federal Aviation Administration, Technical Center, Atlantic City Airport, New Jersey 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: T1102A
12. Sponsoring Agency Name and Address: Federal Aviation Administration, Program Engineering and Maintenance Service, Washington, D.C. 20590	13. Type of Report and Period Covered: Technical Note, January 1985
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report contains the results of bench tests which were performed on the Traffic Alert and Collision Avoidance System (TCAS) Experimental Unit (TEU) delivered by the Massachusetts Institute of Technology (MIT) Lincoln Laboratory. The TEU was used in the Technical Center's helicopter TCAS flight test evaluation.

The results show that the TEU was functioning as designed.

17. Key Words: Rotorcraft Accident Prevention, Helicopter Collision Avoidance, TCA, Midair Collision Avoidance	18. Distribution Statement: Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

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TITLE/SUBTITLE/TITRE/SOUS-TITRE

A Preliminary Investigation of Handling Qualities Requirements for Helicopter Instrument Flight During Decelerating Approach Manoeuvres and Overshoot

4

AUTHOR(S)/AUTEUR(S)

S. Kereliuk, M. Morgan

5

SERIES/SERIE

Aeronautical Note

6

CORPORATE AUTHOR/PERFORMING AGENCY/AUTEUR D'ENTREPRISE/AGENCE D'EXÉCUTION

National Research Council Canada
National Aeronautical Establishment
Flight Research Laboratory

7

SPONSORING AGENCY/AGENCE DE SUBVENTION

8

DATE	FILE/DOSSIER	LAB. ORDER COMMANDE DU LAB.	PAGES	FIGS/DIAGRAMMES
85-02			31	16
9	10	11	12a	12b

NOTES

13

DESCRIPTORS (KEY WORDS)/MOTS-CLÉS

1. Helicopters — handling
2. Helicopters — instrumentation
3. Instrument landings
4. Flight testing

14

SUMMARY/SOMMAIRE

A preliminary flight investigation was carried out to highlight deficiencies of helicopters handling qualities when performing low speed instrument approaches. Steep decelerating MLS approaches to a decision height of 50 feet, simultaneously decelerating to 20 knots, were performed in the NAE Airborne Simulator, a variable-stability Bell 205A helicopter.

Tracking performance, in terms of height, azimuth and speed errors was of an acceptable standard, but pilot workload was extremely high, especially during the overshoot phase. Benefits of different levels of control system augmentation were not readily apparent in this high workload environment.

In view of the results of this investigation, a follow-on program is proposed where further attempts will be made to determine the effects of display and control sophistication on pilot workload during slow-speed helicopter instrument procedures.

15

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-86/10	AD-A167049	

4. Title and Subtitle
Very Short Range Statistical Forecasting of Automated Weather Observations

5. Report Date
March 1986

6. Performing Organization Code

8. Performing Organization Report No.

7. Author(s)
Robert G. Miller, Ph.D.

9. Performing Organization Name and Address
U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Office of Systems Development, Techniques Development Lab., 8060 13th St., Silver Spring, MD 20910

10. Work Unit No. (TRAIS)
156-410-010

11. Contract or Grant No.
DTFA01-83-Y-20625

12. Sponsoring Agency Name and Address
U. S. Dept. of Transportation
Federal Aviation Administration
Program Engineering and Maintenance Service
Helicopter Program, APM-720; Washington, D. C. 20591

13. Type of Report and Period Covered
Interim Report
Oct. 1984 - Sept. 1985

14. Sponsoring Agency Code
FAA/APM-720/APM-650

15. Supplementary Notes
Prepared under FAA/NWS Interagency Agreement No. DTFA01-83-Y-20625, managed by Weather Sensors Program, APM-650, Flight Information Division and Helicopters Program, APM-720, Aircraft Safety and Airport Technology Division.

16. Abstract
A procedure is developed for providing weather forecasting guidance over the short period of 10, 20, 30, ... 60 minutes. It uses automated surface observation elements as predictors and predictands. The model is founded on Markov assumption and utilizes multivariate linear regression as the statistical operator. Details are given on how the Generalized Equivalent Markov (GEM) model is constructed and how it compares with other objective methods such as climatology and persistence. Tests are performed on an independent data sample. Overall, GEM succeeds in bettering persistence and does so uniformly over the 6 projection periods of 10, 20, 30, ... 60 minutes.

17. Key Words
Short-range forecasts
Statistical forecasts
Markov
GEM
Multivariate linear regression

18. Distribution Statement
Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-86/14		

4. Title and Subtitle HELICOPTER MLS FLIGHT INSPECTION PROJECT	5. Report Date April 1986 6. Performing Organization Code ACT-140
7. Author(s) Scott B. Shollenberger and Barry R. Billmann	8. Performing Organization Report No. DOT/FAA/CT-86/14
9. Performing Organization Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City Airport, NJ 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. T0701F
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Final Report April 1986 14. Sponsoring Agency Code

15. Supplementary Notes The Helicopter MLS Flight Inspection Project was conducted jointly by the FAA Technical Center and the AVN Standards National Field Office, Oklahoma City, Okla. FAA Tech Center Project Engineer, Scott B. Shollenberger. Data reduction software support was from Tech Center mathematicians D. Gallagher and P. Maccagnano.

16. Abstract

This report describes test procedures and results of a series of tests designed to identify microwave landing system (MLS) heliport flight inspection procedures. The tests, conducted in November 1985, demonstrated the feasibility of using a helicopter to perform some portion of the flight inspection of the MLS at heliports. Significant findings included the fact that radio theodolite techniques could be used for tracking a helicopter not equipped with stability augmentation equipment. Constituent parts of a portable flight inspection package were also identified and tested.

17. Key Words	18. Distribution Statement
Helicopter Flight Inspection Collocated MLS/Heliport Microwave Landing System	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

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1. Report No. DOT/FAA/PM-86/14 NASA CR 177407	2. Government Accession No. AD-A169947	3. Recipient's Catalog No.
4. Title and Subtitle Technical Requirements for Benchmark Simulator-Based TERPS Evaluation		5. Report Date May, 1986
		6. Performing Organization Code
7. Author(s) A. V. Phatak and J. A. Sorensen		8. Performing Organization Report No. AMA Report No. 86-2-I
9. Performing Organization Name and Address Analytical Mechanics Associates, Inc. 2483 Old Middlefield Way Mountain View, CA 94043		10. Work Unit No.
		11. Contract or Grant No. NAS 2-11973
12. Sponsoring Agency Name and Address NASA-Ames Research Center Moffett Field, CA 94035	FAA Technical Field Office P.O. Box 25 Moffett Field, CA 94035	13. Type of Report and Period Covered Contractor Report
		14. Sponsoring Agency Code APM-450

15. Supplementary Notes

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FAA/Ames Research Center, Moffett Field, CA 94035
(415) 694-6379 or FTS 464-6379

16. Abstract

In order to take full advantage of the helicopter's unique flight characteristics, enhanced terminal instrument procedures (TERPS) need to be developed for a variety of non-standard operational situations. These include non-standard landing navigation aids, precision and non-precision approach profiles, landing sites, and avionics systems. Currently, TERPS criteria are largely established by extensive flight testing. This study examined the requirements for using helicopter cockpit simulators in place of flight testing to generate data necessary for enhanced TERPS development. Specifically, this report identifies and defines which parts of TERPS may be evaluated with the present state of the art in simulator technology. The report also recommends a test plan for benchmark simulator-based TERPS evaluation of standard ILS and MLS approaches using NASA Ames helicopter simulators. Included as part of this investigation were a survey and summary of the current state in modeling of navigation systems, environmental disturbances and helicopter dynamics plus visual and motion simulation; these summaries are included as appendices.

17. Key Words (Suggested by Author(s)) TERPS, Helicopter flight cockpit simulator flight test operational approach profiles		18. Distribution Statement UNCLASSIFIED - UNLIMITED STAR CATEGORY 1 DOCUMENT AVAILABLE FROM NTIS.	
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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-86/15 NASA CR-177408	AD-A169893	

4. Title and Subtitle
Evaluation of the Usefulness of Various Simulation Technology Options for TERPS Enhancement

5. Report Date
May 1986

6. Performing Organization Code

7. Author(s)
A. V. Phatak and J. A. Sorensen

8. Performing Organization Report No.
AMA Report No. 86-2-II

9. Performing Organization Name and Address
Analytical Mechanics Associates, Inc.
2483 Old Middlefield Way
Mountain View, CA 94035

10. Work Unit No.

11. Contract or Grant No.
NAS 2-11973

12. Sponsoring Agency Name and Address
NASA-Ames Research Center
Moffett Field, CA 94035

FAA Technical Field Office
P.O. Box 25
Moffett Field, CA 94035

13. Type of Report and Period Covered
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14. Sponsoring Agency Code
APM-450

15. Supplementary Notes
POINT OF CONTACT: Barry C. Scott - M/S 210-2
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(415) 694-6379 or FTS 464-6379

16. Abstract

Current approved terminal instrument procedures (TERPS) do not permit the full exploitation of the helicopter's unique flying characteristics. Enhanced TERPS need to be developed for a host of non-standard landing sites and navigation aids. Precision navigation systems such as MLS and GPS open the possibility of curved paths, steep glide slopes, and decelerating helicopter approaches. This study evaluated the feasibility, benefits, and liabilities of using helicopter cockpit simulators in place of flight testing to develop enhanced TERPS criteria for non-standard flight profiles and navigation equipment. Near-term (2-5 year) requirements for conducting simulator studies to verify that they produce suitable data comparable to that obtained from previous flight tests are discussed. The long-term (5-10 year) research and development requirements to provide necessary modeling for continued simulator-based testing to develop enhanced TERPS criteria are also outlined.

17. Key Words (Suggested by Author(s))
TERPS, helicopter flight
flight test
cockpit simulator
operational approach profiles

18. Distribution Statement
UNCLASSIFIED - UNLIMITED

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19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN86/17		

4. Title and Subtitle	5. Report Date
LORAN OFFSHORE FLIGHT FOLLOWING PROJECT PLAN	June 1986
	6. Performing Organization Code ACT-140
7. Author(s) Jean Evans and Frank Lorge	8. Performing Organization Report No. DOT/FAA/CT-TN86/17
9. Performing Organization Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City Airport, NJ 08405	10. Work Unit No. (TRAIS) T0702K 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Program Engineering and Maintenance Service Washington, DC 20590	13. Type of Report and Period Covered Project Plan April-October 1986 14. Sponsoring Agency Code APM-450, APM-210

15. Supplementary Notes

APM-450 Helicopter Program Branch
APM-210 En Route Automation Program

16. Abstract

This project plan describes a series of ground simulation and flight tests designed to determine the suitability of Loran Offshore Flight Following (LOFF) in the Gulf of Mexico. LOFF is an automatic dependent surveillance system which will provide a display of traffic outside radar coverage for use by air traffic control. Equipped aircraft will have Loran receivers and an interface unit that will convert Loran derived position to a LOFF message which will then be transmitted by VHF radio. Equipment will be installed in Houston Center which will convert this LOFF message for input to the enhanced direct access radar channel. Target information will then be displayed conventionally on a controller's plan view display.

The testing described in this plan will verify operation and measure accuracy of the converter unit. Flight tests will also be conducted to determine the VHF coverage area and performance of the LOFF system in areas of radar overlap.

17. Key Words	18. Distribution Statement
Loran LOFF Flight Following Automatic Dependent Surveillance	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	24	

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Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN86/22	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle HELIPORT ELECTROLUMINESCENT (E-L) LIGHTING SYSTEM PRELIMINARY EVALUATION		5. Report Date June 1986
		6. Performing Organization Code ACT-310
7. Author(s) Paul Jones		8. Performing Organization Report No. DOT/FAA CT-TN86/22
9. Performing Organization Name and Address Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City Airport, New Jersey 08405		13. Type of Report and Period Covered Technical Note
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This document describes the work performed to determine whether an electroluminescent (E-L) panel heliport lighting system possesses sufficient potential to warrant a full-scale evaluation at the Federal Aviation Administration (FAA) Technical Center.

Flight testing was conducted using the FAA's S-76 helicopter to fly approaches to and orbits around the 60-foot E-L helipad.

Results of the flight testing showed that the E-L system has insufficient intensity and inadequate cut-off angle to support nighttime helicopter operations and therefore does not warrant further evaluation at the Federal Aviation Administration (FAA) Technical Center.

17. Key Words	18. Distribution Statement
Electroluminescent Heliport	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	8	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-86-25,I	AD-A170793	

4. Title and Subtitle	5. Report Date
Aircraft Avionics Suitable for Advanced Approach Applications Vol. I - Aircraft Fleet Equipage	July 1986
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Stanley Kowalski, Thomas H. Croswell	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
RJO Enterprises, Inc. 4550 Forbes Boulevard Lanham, Maryland 20706	11. Contract or Grant No. DTFA01-84-Y-01051
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Department of Transportation Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591	Avionics Study
	14. Sponsoring Agency Code APM-430

15. Supplementary Notes

APM-430 Cockpit Technology Program Office
J. P. McVicker

16. Abstract

This report catalogs the aircraft avionics suitable for advanced approach applications. The configuration and model numbers of avionics used in navigation and approaches for landing are provided for 79 different types of aircraft. Aircraft are grouped into five user communities which cover Major Air Carriers, Regional Air Carriers, Executive Jets, General Aviation Aircraft, and IFR Helicopters.

Avionics evaluation includes VOR NAVs, ADFs, DMEs, RNAVs, AFCS, weather radar and the associated display instruments. These navigation systems are the most popular units for navigation and landing in todays aircraft. ILS glideslope receivers, marker beacon systems, navigation management systems, vertical navigation systems, and long range navigation systems are not covered.

17. Key Words	18. Distribution Statement
Aircraft Cockpit-Panel NAV RADAR Avionics Equipage ADF RNAV Navigation Avionics HSI Navigation Instruments RMI IFC CDI	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	110	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-86/28	AD-A171994	

4. Title and Subtitle	5. Report Date
INVESTIGATION OF HAZARDS OF HELICOPTER OPERATIONS AND ROOT CAUSES OF HELICOPTER ACCIDENTS	July 1986
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Franklin R. Taylor and Richard J. Adams	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Systems Control Technology, Inc. 1611 N. Kent Street Suite 905 Arlington, VA 22209	11. Contract or Grant No. DTFA01- 80-C-10080/Mod. 0034
	13. Type of Report and Period Covered FINAL REPORT October 83 - September 85
12. Sponsoring Agency Name and Address	
Federal Aviation Administration Navigation and Landing Division Helicopter Program Branch, APM-450 800 Independence Ave., Washington, D.C. 20591	14. Sponsoring Agency Code APM-450

15. Supplementary Notes

16. Abstract

During 1983 and 1984, Systems Control Technology, Inc. conducted a survey of civil helicopter pilot organizations from throughout the United States who were involved in a wide range of helicopter operations for the purpose of determining the hazards of helicopter operations and the root causes of the high rate of helicopter accidents. The survey was administered through personal interviews, meetings, and questionnaires. The derived questionnaire data included census data, profiles of the pilots work environment and procedures and their own perspectives on the hazards of helicopter operations and root causes of helicopter accidents. These data were compared with historical National Transportation Safety Board accident reports and accident briefs to determine more specifically the root causes of helicopter accidents. The results of the analysis include a list of hazards and probable root causes of accidents, as well as technological, training and standardization remedies to the causes.

17. Key Words	18. Distribution Statement
Helicopter, accidents, autorotation, hazards, pilot error	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	170	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-86/30		

4. Title and Subtitle	5. Report Date
THE SITING, INSTALLATION, AND OPERATIONAL SUITABILITY OF THE AUTOMATED WEATHER OBSERVING SYSTEM (AWOS) AT HELIPORTS	August 1986
	6. Performing Organization Code: ACT-140
7. Author(s) Rene A. Matos, John R. Sackett, Philip Shuster, and Rosanne M. Weiss	8. Performing Organization Report No. DOT/FAA/CT-86/9
9. Performing Organization Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City Airport, N.J. 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No. T0705A
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590	13. Type of Report and Period Covered Final Report February 1985-April 1986 14. Sponsoring Agency Code APM-450, APM-650

15. Supplementary Notes

AWOS Program (APM-650), Helicopter Program (APM-450)

16. Abstract

An Automated Weather Observing System (AWOS) was installed at the Federal Aviation Administration (FAA) Technical Center's Interim Concept Development Heliport. This was done in order to evaluate the siting, installation, and operational suitability of the AWOS at a heliport. The principal recommendations of this report have been incorporated in FAA Advisory Circular (AC) 150/5220-16, Automated Weather Observing Systems (AWOS) for non-federal applications.

17. Key Words	18. Distribution Statement
Automated Weather Observing Systems (AWOS) Analysis of Variance (ANOVA) Helicopter Heliport	This document is available to the U.S. public through the National Technical Information Service, Springfield, Va. 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	64	

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN86/31		

4. Title and Subtitle	5. Report Date
EVALUATION OF SIKORSKY S-76A 24 MISSED APPROACH PROFILES FOLLOWING PRECISION MLS APPROACHES TO A HELIPAD AT 40 KIAS	October 1986
	6. Performing Organization Code: ACT-140
7. Author(s): Michael M. Webb	8. Performing Organization Report No.: DOT/FAA/CT-TN86/31
9. Performing Organization Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Technical Center, Atlantic City Airport, NJ 08405	10. Work Unit No. (TRAIS)
	11. Contract or Grant No.: T0701B
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Federal Aviation Administration, Program Engineering and Maintenance Service, Washington, DC 20590	13. Type of Report and Period Covered: Technical Note, August 1985-July 1986
	14. Sponsoring Agency Code: APM-450

15. Supplementary Notes

16. Abstract

This report describes the "trend analysis" evaluation of the Sikorsky S-76A missed approach profiles following precision microwave landing system (MLS) approaches at glidepath angles of 3°, 6° and 7.5° at a minimum instrument meterological conditions airspeed (V_{mini}) of 40 knots indicated airspeed (KIAS). It describes the flight test facilities, methodology, and addresses topics such as how flight test data are collected and what is done with it. It also describes each of the helicopter procedures flown during the project and provides an analysis of the pilots subjective opinions concerning the acceptability and workload associated with these procedures.

It was concluded that the "trend" indicates that no current terminal instrument procedures (TERPS) criteria would be violated by reducing V_{mini} to 40 KIAS. The plots indicated that there were no penetrations of the 20:1 surface missed approach surface. The maximum deviation allowed by TERPS for the height loss at missed approach rises along a 20:1 plane which begins at the surface or 250 feet below the missed approach point. For this test that meant that the 20:1 obstacle free surface began at ground level. At most, only a 40-foot fly under at decision height (DH) was noticed during the 24 missed approaches flown.

However, this information should be considered indicative rather than conclusive due to the small sample size (24 approaches). Additional testing would be required to provide TERPS quality data.

17. Key Words	18. Distribution Statement
MLS Helicopter Helicopter Certification Precision MLS Approaches	Document is on file at the Technical Center Library, Atlantic City Airport, New Jersey 08405

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/PM-86/45		
4. Title and Subtitle Aeronautical Decision Making for Helicopter Pilots		5. Report Date November 1986 6. Performing Organization Code
7. Author's) R. J. Adams, J. L. Thompson		8. Performing Organization Report No.
9. Performing Organization Name and Address Systems Control Technology, Inc. 1611 North Kent Street, Suite 905 Arlington, VA 22209		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFA01-80-C-10080
12. Sponsoring Agency Name and Address U. S. Department of Transportation Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code AAM-500 APM-450

15. Supplementary Notes

AAM-500 Biomedical and Behavioral Sciences Division
APM-450 Navigation and Landing Division, Helicopter Program Branch

16. Abstract

Aviation accident data indicate that the majority of aircraft mishaps are due to judgment error. This training manual is part of a project to develop materials and techniques to help improve pilot decision making. Training programs using prototype versions of these materials have demonstrated substantial reductions in pilot error rates. The results of such tests were statistically significant and ranged from approximately 10% to 50% fewer mistakes.

This manual is designed to explain the risks associated with helicopter flying activities, the underlying behavioral causes of typical accidents, and the effects of stress on pilot decision making. It provides a means for the individual pilot to develop an "Attitude Profile" through a self-assessment inventory and provides detailed explanations of pre-flight and in-flight stress management techniques. The assumption is that pilots receiving this training will develop a positive attitude toward safety and the ability to effectively manage stress while recognizing and avoiding unnecessary risk.

This manual is one of a series on Aeronautical Decision Making prepared for the following pilot audiences: (1) Student and Private (2) Commercial (3) Instrument (4) Instructor (5) Helicopter (6) Multi-Crew.

17. Key Words		18. Distribution Statement
Human Factors	Judgment	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.
Human Performance	Decision Making	
Aviation Safety	Helicopter Pilot	
Aviation Training	Helicopters	
Pilot Error	Rotorcraft	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	117	

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AVN-200/25		

4. Title and Subtitle	5. Report Date
Helicopter MLS Flight Test	June 1986
	6. Performing Organization Code AVN-210
7. Author(s) C. Hale & P. Maenza	8. Performing Organization Report No.
9. Performing Organization Name and Address FAA Standards Development Branch, AVN-210 P.O. Box 25082 Oklahoma City, OK 73125	10. Work Unit No. 10046 11. Contract or Grant No. AVN-210-83-3
12. Sponsoring Agency Name and Address The Standards Development Branch Flight Programs Division Aviation Standards National Field Office	13. Type of Report and Period Covered Memorandum Report 14. Sponsoring Agency Code AVN-210

15. Supplementary Notes

Flight data acquisition ACT-100

16. Abstract

A MLS flight test was conducted to a helipad using the Sikorsky S-76. Fifteen pilots each flew 24 approach procedures following a standardized videotaped briefing while using the 1020 IMC simulator, a new view limiting device. Tests were flown at the FAATC, Atlantic City, New Jersey. Approach angles were 3°, 6°, and 9°. Tracking of aircraft was by laser ground tracker. Airborne data were also recorded. Analyses were made of TSE, FTE, and NSE. A comprehensive pilot questionnaire was accomplished after flight. It was found that while 3 and 6° approach angles were acceptable, the 9° angle was not. Course sensitivity used was acceptable. A two-pilot crew would be desirable for IFR operations. There is altitude loss below the DH on missed approach.

17. Key Words	18. Distribution Statement
Helicopter Approach Helicopter Missed Approach MLS Approach Helicopter MLS	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	111	

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